NEXT MONTH

Perhaps the biggest job before the chemical and process industries in the next two years is expansion to meet the needs of the defense program. Faced with new demands, most companies will shortly have, if they have not already had, to study the questions of *whether, where* and *how* to expand. New problems in emergency economics, shortages and priorities in essential construction materials, will have to be faced. Therefore, in May, *Chem. & Met.* will devote a 48-page special section to these matters, to plant layout, design and construction.

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CHEMICAL & METALLURGICAL ENGINEERING

ESTABLISHED 1902

CONTENTS

VOLUME 48 — APRIL, 1941 — NUMBER 4

For a Better Balanced Economy 69
EDITORIAL FOREWORD

Mid-West Builds Biggest U. S. Powder Plant 72
By S. D. KIRKPATRICK

Hydroforming: A New Refining Process 77
By D. J. SMITH and L. W. MOORE

Modern Practice in Solvent Extraction 80
By W. H. GOSS

What Soybean Processing Costs 85
By C. W. BILBE

Investing in "Chemicals"—The Industry 86
By ROLAND P. SOULE

Cotton Linters Purification 90
By J. A. LEE

Air Raid Defense of Industry 92
By CURT WACHTEL

Chemical Industries' Role in Midwestern Economy 95
A *CHEM. & MET.* REPORT

Making Smokeless Powder at Radford 103

Purifying Cotton Linters 108
A *CHEM. & MET.* PICTURED FLOWSHEET

Process Equipment News	104	Chem. & Met. Bookshelf	145
Chem. & Met. Plant Notebook	115	Government Publications	153
News From Washington	116	Manufacturers' Publications	155
Chemical Engineering News	118	Chemical Economics and Markets	159
Personalities	127	Current Prices	165
Meetings and Conventions	135	New Construction	168

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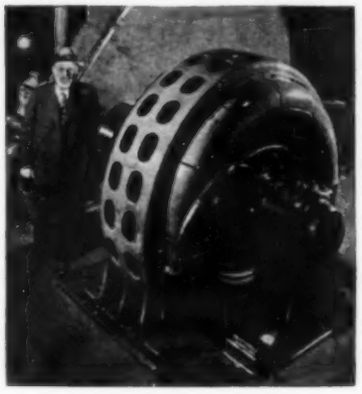


TWO ALLIS-CHALMERS 300-HORSEpower motors keep eleven miles of underground cable in steady motion 20 hours a day to operate the famous California Street cable cars. Shown here with one of the motors is 86-year old James W. Harris who recently retired as president of the company.

If this is the type of motor performance you want in your plant get the facts about Lo-Maintenance Motors. The engineer in the district office near you will be glad to give you the information you want. Or you can write Allis-Chalmers, Milwaukee, Wisconsin.

A 136

ALLIS-CHALMERS LO-MAINTENANCE MOTORS

CHEMICAL
& METALLURGICAL
ENGINEERING

ESTABLISHED 1902 S. D. KIRKPATRICK, *Editor*

APRIL, 1941

FOR A BETTER BALANCED ECONOMY

A YEAR AGO when the national defense program was still in the planning stage, there was considerable talk in Washington about the possibilities of decentralizing munitions production. Frankly, it seemed a bit illogical to some of us who thought the government would have to get its defense materials pretty much where it found them. Mines and steel works and huge chemical plants were not pawns to be pushed around the map at will by the economic planners. But gradually, as the defense program is unfolding, these very policies begin to take on more interesting possibilities.

When the buying of munitions and supplies first got under way, most of the defense contracts were placed with the established industries that had been manufacturing similar or related peace-time materials. This meant a heavy concentration of purchasing along the Atlantic Seaboard and in the highly industrialized metropolitan areas. Then, almost simultaneously, the government announced its plans for a great series of new plants to make arms, ammunition and explosives. For strategic reasons, these plants were located far enough into the interior to be safe from any except the longer-range bombers. Selection of sites like Charlestown, Ind., Burlington, Ia., Kankakee, Ill. and Ravenna, Ohio, occasioned some surprise until it became evident that a more fundamental policy than military expendiency was involved. A new geographic pattern was being worked out to put these plants into areas where there were undeveloped reserves of labor and natural resources. And it will not be surprising, therefore, to see shortly a second chain of huge plants for the lend-lease program and for further expansion of our own defense located still further west, perhaps in the states beyond the Mississippi and east of the Rockies.

As these plants draw most of their workmen and supplies from surrounding territories, there is no occasion for any dangerous migration of labor to industrial centers that are already over-crowded. Money spent in these local communities is quickly reflected in increased purchasing power and higher living standards. Training programs have already developed latent skills and opened up great untouched reservoirs of factory employees. It may well be expected that many of these defense plants, especially in the Middle West and the South, will eventually become the centers for important peace-time industries.

Chemical industries are in a peculiarly favorable position to benefit by this decentralization trend. They can use most effectively the type of workers who become skilled in the operation of munition plants. They already draw on agriculture for many of their raw materials and in other instances new crops might be developed to effect a better balance between farm and factory. What has come to be known as "Chemurgy" will find its greatest opportunity in those parts of the country where the defense program has already helped to diversify the interests of both agriculture and industry.

A concomitant benefit that should come out of this program of new plant expansion is in the modernization of manufacturing equipment. There have been many recent advances in engineering and technology that could not readily be applied in the extension of existing plants. But starting from ground up—to change an Indiana cornfield into the world's largest smokeless powder plant, for example—has opened up many attractive opportunities for improved techniques in design, construction and operation. The men and machinery that make these achievements can carry them still further in new peace-time industries.

So what started out as a dream of the economic planners may prove to have some lasting benefits for industry, provided full advantage is taken of the chance to decentralize production and to relate it more directly with the peace- as well as the war-time needs of our country. A better balance between industry and agriculture can become the basis of a sounder economy in which both may grow and prosper.

FROM AN

ANOTHER SLICE FOR TVA

AUTHORITY has been given to provide for the expansion of phosphoric-acid facilities by TVA from 100,000 to 150,000 tons per year of triple superphosphate. This increase will be accomplished by adding new phosphoric acid furnaces at Muscle Shoals. The result will be a diversion of more power from immediate defense projects to the expansion of the government's fertilizer business.

The argument advanced in favor of this development is interesting and illuminating. It runs about like this: A.A.A. cannot buy all the high-concentration fertilizer it would like to have to continue its educational program for the farmers. Lest there should be a shortage of food, it wants to teach the farmers how to grow more crops per acre, especially truck crops. Thus, even in an emergency period, the agricultural-educational-fertilizer-reform program must expand. Meanwhile, chemical industry, up to its ears in the defense program, must and will carry on while the government cuts off another slice of cake.

CAN PROCESS PLANT SHOPS HELP?

GOVERNMENT and industry are cooperating intensively in gearing the tremendous productive plant of the United States to the defense effort. Production and more production is essential, yet valuable time is passing, and bottlenecks in plant, equipment and personnel are being encountered with distressing frequency. Is it possible that we are over-looking a small but still useful section of the metal-working industry—the shops for maintenance and equipment building which are such an essential, but still a little noticed, part of the chemical process industries?

Many plant shops in the process field are large, well equipped and efficiently staffed. Probably the first reaction of most managements will be "But our shop is already overloaded!" Is it actually overloaded? Is it working 24 hours a day, or possibly only eight? Might it not be feasible to employ the shop's machine tools and welding equipment during otherwise idle time in sub-contracting for holders of primary government contracts in the neighborhood?

The procedure in bringing together sub-contractors and primary contractors is not yet completely worked out. However, there are ways. For example, the Federal Reserve district offices have, or will have shortly, complete lists of prime contracts in the district. The Office of Production Management issues the weekly bulletin, *Defense*, in which all large prime contracts are summarized. Furthermore, local newspapers take note of such contracts and their advertising columns may, in some instances, be a suitable medium for bringing the process plant shop to the attention of prime contractors whose facilities could thus be extended. Individual circumstances will determine how far a given plant can help with the program, but in many cases the suggested plan is one that well deserves consideration.

WHOSE STOCK-PILES ARE WE BUILDING?

LARGE stocks of high-test aviation gasoline are being made by industry for the benefit of the government. This is as it should be. But it looks as though the government was not doing quite all of its part in this particular job. Many divisions of the chemical process industries will be concerned—not alone the petroleum refiners. A fundamental matter of division of responsibility is involved.

When the 100-octane gasoline is made, it should not be indefinitely the responsibility of the industry to maintain the reserve stock. The government should take steps both to buy and to store the material itself in government-owned tankage. Dr. R. E. Wilson, who is so ably managing petroleum refining problems at O.P.M., should receive more encouragement in his campaign to have the government build its own "stock-pile."

Some chemical firms who are now dealing with the government on contracts for other munition materials need to take notice of this situation. They must make it a part of their agreements with the government that the latter should take title and provide storage space for goods that are made on its orders. The government can not

EDITORIAL VIEWPOINT

reasonably expect the industry to build capacity for production and use this for manufacture and then store indefinitely the results of its production. Few, if any, units of chemical industry have a sufficient financial reserve to do this. Such a plan would quickly exhaust the working capital of most companies. Besides it makes it just that much more difficult for industry to help in the defense program.

PETROLEUM AND NATIONAL DEFENSE

As THE thoughts of the nation turn increasingly toward matters of national defense, it is proper to take stock of those things which constitute our security. Where do we stand now? Where will we stand next year? Answers to these questions, when applied to the petroleum industry, are singularly encouraging.

Proved reserves of petroleum, estimated at more than 19 billion barrels as of January 1, 1941, are highest in the history of the country. In fact, discovery during the past year outstripped total production by almost 40 percent. But regardless of these reserves, can the production capacity for crude petroleum meet any probable increase in demand? Detail estimates relieve this fear, since they indicate it is possible to increase by 30 percent the present rate of crude-oil production and to continue this for two years without new discoveries or any unusual amount of drilling.

As to the ability of the oil industry to meet future refining demands, there appears to be no cause for concern, according to R. E. Wilson, consultant on petroleum in the Production Division of O.P.M. By starting up units which are now shut down, refining could be increased fully 25 percent over the largest yearly production in the history of the domestic industry. As compared to this available capacity, the total domestic demand under peace-time conditions for 1941 is estimated to be 8 to 9 percent greater than that for 1940. A *further* increase of only 5 to 10 percent would be necessary should America decide to make an all-out war effort by the end of this year. Furthermore, the industry already has constructed capacity to meet more than twice the present domestic and foreign demand for 100-octane aviation gasoline. Incidentally, the entire military and industrial activities of Germany, Italy and the occupied areas of Western Europe are reported to be carried on with petroleum and synthetic substitutes equivalent to only about 5 percent of the present United States production.

Certainly the nation need have no undue fears for the near future either in respect to oil reserves, production of crude oil or refining capacity. Instead, it would be more appropriate to thank the petroleum technologists for doing some handy rescue work in other fields. For almost within the last year it has been announced that two strategic materials, synthetic rubber and glycerine, could be produced in large quantities from refinery gases. And now, elsewhere in this issue, the Pan American Refining Corp. announces the successful operation at Texas City of the world's first hydroforming refining unit from which upward of 25 percent of this nation's normal peacetime requirements of toluene could readily be supplied. Thus the petroleum industry solves other "musts" of national defense.

EXPANSION IN SOYBEAN PROCESSING

SOYBEAN CRUSHERS seem to be expanding more vigorously than any other of the animal and vegetable oil processors. Data supporting this statement have been gathered for the first time by the U. S. Census of Manufactures, and recently released with the 1939 statistics. Further evidence is contained in the comprehensive article and the abstract which follows it, starting on page 80 of this issue. A number of calculations made from the Census data appear on page 84.

These data, evident from the Census' first compilation of information on expenditures for plant and equipment in the oil producing industry, show that soybean processors not only spent four times as much per establishment as the average for the industry, but also spent more than twice the average amount per dollar value of product. Each establishment in the soybean industry turns out a little more than the average in dollar value of product, but is below the essential oil industry in dollar value, and only about a third of the linseed oil industry. A significant fact is evident in that the soybean industry, with only 9 percent of the total number of establishments in the animal and vegetable oil industry, nevertheless made 34 percent of the expenditures for plant and equipment.

Mid-West Builds Biggest

SIDNEY D. KIRKPATRICK Editor, *Chemical & Metallurgical Engineering*

Chem. & Met. INTERPRETATION

On May 1, or shortly thereafter, operations are to start at what is probably the world's largest plant for the production of smokeless powder. In less than nine months, 5,400 acres of rich farmland in Southern Indiana have been transformed into a thriving industry employing thousands of skilled workmen and technically trained men. Speed and thoroughness of construction emphasize the resourcefulness of the engineers from industry who have been working for years with the Army Ordnance officials in planning and preparing for this emergency. These new government-owned and industry-operated plants are virtual arsenals of defense and there is almost unanimous agreement among defense authorities that they should always be maintained in efficient operating condition.—*Editors.*

It is no longer a secret. The United States will soon have the largest smokeless powder plants in the world and, if authorities in Washington have their way, the country will never again be caught without such facilities so vital to the national defense.

At Charlestown, Ind., a little village near the Ohio River, 17 miles from Louisville, Ky., more than 20,000 people are now at work building a great $75,000,000 plant which, with a somewhat smaller plant at Radford, Va., will ultimately be turning out 900,000 lb. of powder per day. The latter commenced operations on March 17 (see page 103) and such rapid progress is being made at Charlestown that by May 1—nine months after ground was broken—the first two of its six powder lines are expected to be in full operation. The remainder of the plant will be completed as promptly as possible and before long a third new government-owned plant at Childersburg, Ala. will add its 300,000 lb. output to this sizeable total. Smokeless powder need no longer be considered the most serious bottleneck in our defense program.

Some idea of the magnitude of the Charlestown project may be gathered from the fact that the plant site of 5,400 acres is surrounded by 15 miles of fence, that it will have in all 650 buildings served by 50 miles of standard gage railway track and perhaps 25 miles more of narrow gage. The water requirement of 70,000 gal. per min. or 100,000,000 gal. per day is carried through 20 miles of water main, much of it 36-in. cast-iron pipe. There are two power plants each equipped to convert approximately 20,000 gal. of water per hour into steam at 700 deg. F. and 550 lb. gage. Four 5,000-kva. turbo-generators in each power plant operate at 525 lb., extracting steam at 150 lb. and 50 lb. per sq.in.

In contrast with the temporary plants that were built in 1917 and 1918 at Old Hickory, Tenn., Hopewell, Va. and Nitro, W. Va., the Indiana Ordnance Works at Charlestown is being constructed for a prospective life of 25 years. This is certain to prove a good investment for Uncle Sam. Simple, well-built brick buildings will be more economical in the long run than the flimsy frame structures that were used so often in the munitions plants of the first World War. Where wood construction is essential, as in many of the processing buildings and storage houses, heavily reinforced timbers make the buildings almost the equivalent of steel or concrete. The entire plant gives one the impression of careful design and rapid but efficient construction.

The Charlestown plant is being built by the Munitions Construction Division of the Engineering Department of E. I. duPont de Nemours & Co., Inc. Expanding from a small nucleus in 1939, this division first designed and built the plant at Mem-

Power house with nitric and sulphuric acid concentrator to the left. These units supply the first two of the six powder lines

Photo by U. S. Army Signal Corps

U. S. Powder Plant

phis, Tenn. which is now producing smokeless powder for the British. In addition to the Charlestown project the company has undertaken to build and operate another smokeless powder plant in Alabama, to construct an additional plant at Memphis for the British to manufacture trinitrotoluol and dinitrotoluol and to supervise and subsequently operate a similar plant at Wilmington, Ill. for the U. S. Government. These plants are built and will be operated on the basis of fixed fees rather than the cost-plus-10 percent plant that fell into disrepute in the last war. It is understood that the construction fee in the case of the Charlestown plant is approximately $500,000 or but 0.7 percent of the estimated cost. The recent annual report of the duPont Company shows that the total cost of the government plants it has contracted to build in 1941 will be $282,000,000 and that the fees for the construction and operation will amount to about 4 percent before taxes.

When the writer visited the Charlestown plant on February 1, more than 17,000 workers were being employed on the basis of three shifts of eight hours each. Assisting the duPont engineers were 30 subcontractors with 3,500 additional employees. G. P. Church is construction superintendent at Charlestown and M. R. Warden, general construction superintendent for all plants. Granville M. Read is manager of the Munitions Construction Division of the Engineering Department under E. G. Ackart, chief engineer in the Wilmington, Del. headquarters of the Engineering Department. Representing the United States Government is the Constructing Quartermaster Lt. Col. R. E. Hardy of the Ordnance Department who is assisted by approximately 15 other Army officers. In civilian life most of these men were chemical, civil and mechanical engineers, and it is their responsibility to check the progress and quality of the construction. Later they will have similar responsibilities in connection with plant operation.

The speed and efficiency with which this project is being constructed are the result of careful planning on the part of the Army and the duPont Company long before the funds were authorized for any construction. As early as July, 1937, Brig. Gen. Charles T. Harris, Jr., assistant chief of ordnance in charge of production, and Brig. Gen. Levin H. Campbell, Jr. in charge of building facilities, had been working with the duPont engineers through the Wilmington offices of Major John P. Harris of the Ordnance Department. With funds made available in 1938, Major Harris spent more than $6,000,000 for the purchase of powder machinery and specialized equipment such as dipping pots, ammonia oxidation units, and hydraulic presses that might not be readily available in emergency. These were stored at Picatinny Arsenal in New Jersey, which at the present time is the largest government-owned plant for smokeless powder manufacture. The remainder of our present supplies are largely obtained from the duPont plant at Carney's Point, N. J.—one of the very few privately-owned powder plants of the World War era that did not fall under the hatchet of the pacifists with our return in 1919 to alleged "normalcy."

Before referring briefly to the general flowsheet of the process used in all of the government's new smokeless powder plants, some further observations on Charlestown may be in order. First, as to its location, it will be noted that it closely approaches the ideal specifications of the War Department which Lt. Col. A. R. Ginsburgh described in our November, 1940, issue, pp. 768-9. It is far enough inland to be relatively safe from other than the longest range of aerial bombers. It is near enough to draw on the big industrial populations of Louisville and nearby cities in Indiana and yet sufficiently removed from these to present no hazard to civilians. If necessary, it has the whole Ohio River for water supply and to provide ample dilution for its wastes. Good transportation by rail and highway is important although the source of most of its raw materials and the outlets for its finished products are relatively near at hand.

One of the government's two new ammonia plants is to be at West Henderson, Ky., a few miles in the other direction from Louisville. Cot-

First stage processing houses for the third pair of powder lines. Photographs for this and opposite page taken March first
Photo by U. S. Army Signal Corps

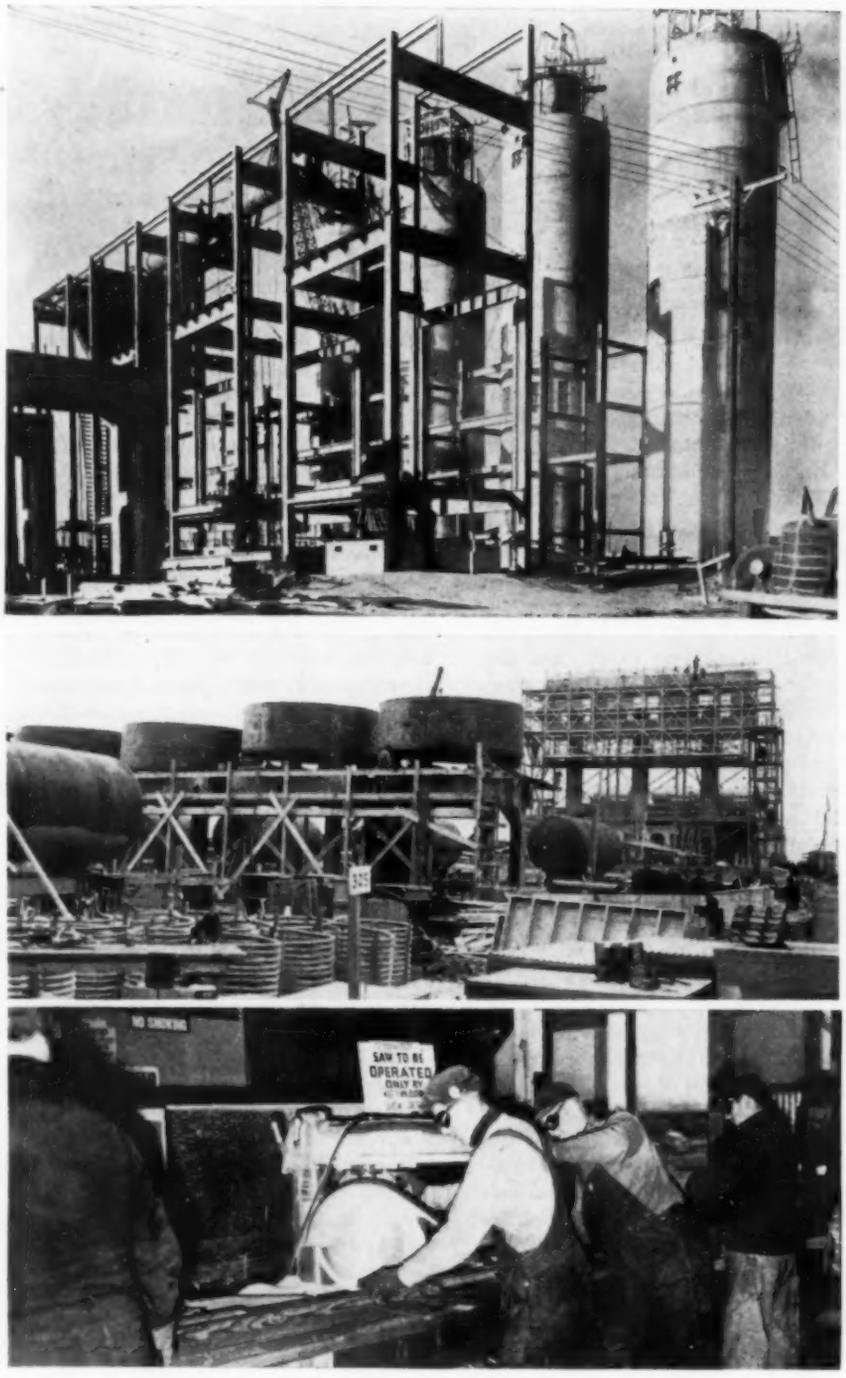
ton linters may be brought up the river from the South. Some of the country's largest sulphuric acid plants are in Tennessee. Alcohol and ether made from molasses or petroleum hydrocarbons are also products of midwestern industries.

From the standpoint of the finished product, Charlestown's output will not have far to travel. Part of it will be packed in silken bags at an adjoining bag-loading plant to be built for the government by a subsidiary of the Goodyear Tire & Rubber Company. Most of the remainder will go to shell loading plants at Ravenna, Ohio, Ellwood, Ill., Union Center, Ind., and Burlington, Ia. A few miles north of Charlestown, the government is building a proving ground for small arms ammunition and another one for artillery shells at Madson, Ind.

After the site had been selected and the necessary acreage purchased last summer, construction started in earnest on September 3. The duPont engineers and construction crew had already gained valuable experience in Memphis and were able to introduce many important economies as well as practical means of speeding up the work. Modern ditching machines were soon digging foundations while a concrete mixing plant, with a capacity of 2,000 cu.yd. per day, was being installed. Serviceable highways and railway trackage were rushed to completion. Lacking a power plant to supply steam needed at various parts of the huge plant site, the company was fortunate in being able to rent four large locomotives from the B. & O. Railroad which could supply the needs wherever they occurred and then move on to the next job.

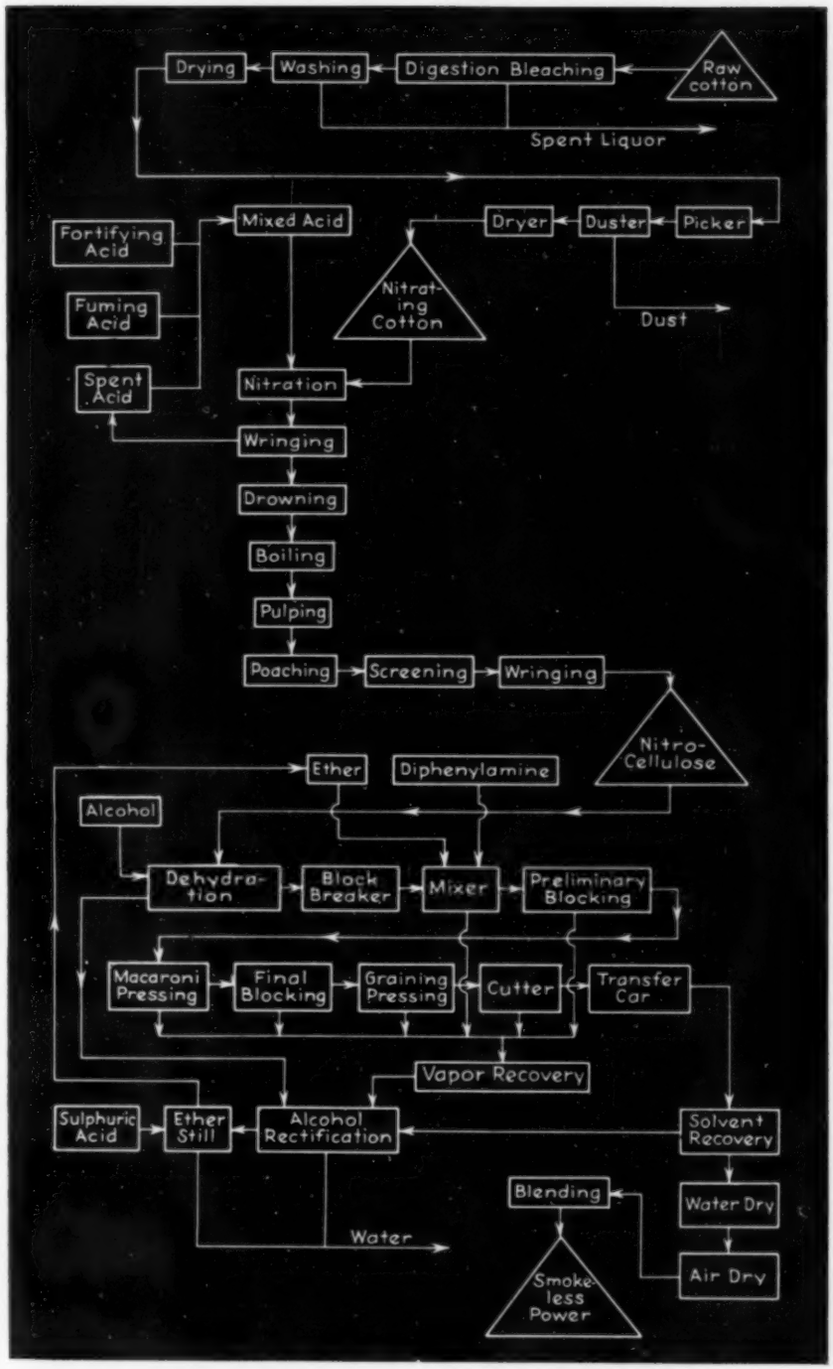
All the lumber is prefabricated on the ground or at the site. A sawmill built on the grounds saved time in shaping the 20,000,000 board ft. of lumber that were required. Much of the structural steel, of which 62,000 tons will be used, is purchased in prefabricated form. Approximately 25 "expediters" are maintained in the plants of the suppliers of materials and machinery to make certain that shipments are made and goods received in accordance with the building schedule. To make doubly sure that there will be no delay, the company has worked out its own system of priority ratings which the Army has helped to enforce on a "voluntary" basis.

Despite the great urge for speed all through the job, there seemed to the writer to be a minimum of confusion and a maximum of carefully planned precautions against accidents. The safety records of the plant which are posted daily on the bulletin boards, show that the men have worked as many as 4,000,000 man-hours without a single lost-time accident. This established a new All-American record for construction work. So far there have only been three rather minor injuries to men, which even under more normal circumstances is a remarkable record.



Views of early stages of construction. Top—Silos for coal storage for power plants. Nitric acid plant and ammonia oxidation units (center). And (bottom) interior of sawmill where lumber is pre-cut to expedite erection of buildings and forms

Also one observes that the plant is being built with extreme care in order to provide all possible safety precautions and devices. Metal equipment is grounded with heavy copper conduits to carry off dangerous charges of static electricity. Buildings are spaced at standard distances to prevent spread of hazard in case of fire or explosion. An efficient, highly qualified staff of guards is on duty day and night to prevent any infiltration of spies or industrial



Flow diagram of a powder line showing steps in the conversion of raw cotton — usually linters—into smokeless powder. There are three pairs of such lines at Charlestown. (From "Military Explosives," War Department Technical Manual No. 9-2900)

saboteurs. Their job as well as that of the construction force is made easier at night by the extensive use of incandescent and flood-lighting.

Details of the arrangements and function of the various buildings and equipment at Charlestown are military secrets, which cannot be discussed even in the most general terms. However for chemical engineers who are interested in smokeless powder manufacture, and may wish to become more familiar with the general features of the process, the War Department has recently published a revised edition of its Technical Manual (No. 9-2900) on "Military Explosives," which is available from the Superintendent of Documents in Washington. The accompanying flowsheet on the manufacture of smokeless powder is reproduced from that publication which is also the source of the following notes:

Six steps common to all processes for the manufacture of smokeless powder include: (a) Purification and mechanical preparation of cotton linters, or wood pulp if that is to be used; (b) Nitration of the purified cotton using a mixture of nitric and sulphuric acids; (c) The cellulose nitrate or "pyrocotton" thus produced is purified to remove all traces of free acids and lower nitrates; (d) Mixing of pyrocotton with ether-alcohol and pressing to form a colloid; (e) Granulating the powder by pressing the colloid through steel dies; (f) Final processes of solvent recovery, drying and blending. The order of these various steps is shown in the accompanying flowsheet.

In the duPont mechanical dipper process of nitration, which according to the War Department Manual has practically displaced all other processes in this country, the various steps are outlined as follows:

A nitrating unit in this system consists of a battery of four iron or stainless-steel nitrators so situated that they can all be handled from a central point. In each nitrator are two vertical revolving paddles operated in opposite directions from each other, the motion being from without inward. These paddles consist of a series of horizontal arms so placed upon the post that when set in motion the cotton is quickly drawn beneath the surface of the acid. A charge of approximately 1,500 lb. of acid having a temperature of 30 deg. C. is used in each nitrator of which the following is a fair average composition: HNO_3, 21 percent; H_2SO_4, 63 percent; N_2O_4, 0.5 percent; H_2O, 15.5 percent.

When the acid has been run in, the paddles are set in motion and about 32 lb. of cotton added. The speed of these paddles is approximately 60 r.p.m. Nitration is continued for 24 min. after which the bottom discharge valve is opened and the nitrocotton and acid dropped rapidly into a centrifugal wringer located below the nitrator unit. This centrifugal wringer rotates slowly at first at about 300 r.p.m. until the whole charge is in the centrifuge. The speed of the wringer is then increased to about 1,100 r.p.m. and held at this rate for 3½ min. The spent acid is run by gravity from the outer jacket of the wringer into catch tanks where small amounts of nitrocellulose settle out. The spent acid runs from these catch tanks to a blow case, and is either blown into mixing tanks or any surplus spent acid set aside for denitration or other means of disposal.

The nitrated cotton obtained is forked through a bottom discharge of the centrifuge into an immersion basin below. As fast as the nitrated cotton falls into the basin it is submerged by a heavy stream of water distributed by fishtail or other form which combines the greatest dispersion of water with the maximum

force for submersion. The pyrocotton, as it is now called, is next transferred by means of pumps or by gravity to the boiling tub house.

Next follows the general cycle or sequence of processes of preliminary boiling, pulping, poaching, screening and wringing. The preliminary boiling is carried out in large wooden tubs, constructed of cypress and having false bottoms. The steam is introduced through a square wooden duct in the center of each tub and the pyrocotton is alternately boiled and washed with water for about 40 hr. during which there have been at least four changes of water.

The pulping process is accomplished in beaters of the Jordan engine type so widely used in the pulp and paper industry as to make description here unnecessary. When the desired degree of fineness is obtained, the material is ready for the so-called "poaching." This is a boiling process, carried out in equipment similar to that used in the boiling tub house except that in this case an alkaline solution is used for the first treatment. This is made up of one lb. of soda ash per gallon of water and for every ton of dry nitrocellulose, five gal. of solution are required. After the alkaline boiling, the pyrocotton is given at least ten washings with cold water or until the material meets certain rigid tests for stability, nitrogen content, solubility, etc.

Screening is effected by means of the Packer pulp screen, the bottom of which is fitted with a brass plate having slits 0.025 in. in width. The pulp drawn by suction through these slits is thus rid of any foreign material or coarse particles. The final purification step is the wringing in a basket-type centrifuge, revolving at about 950 r.p.m. for seven min. which is sufficient to bring the moisture content down to between 26 and 28 percent. This operation concludes the actual manufacture of pyrocotton itself.

From then on the steps are concerned with the removal of the remaining water with alcohol and the collodizing of the dehydrated material with the ether-alcohol mixture. The dehydrating operation is conducted in specia. hydraulic presses that exert a final pressure as high as 3,500 lb. per sq.in. The dehydrated blocks from the press are transferred to a rotary drum or block breaker in order to prepare the material for mixing with the ether-alcohol. In average operations on cannon powder, about 1 lb. of solvent (one part of alcohol to two parts of ether), are used per pound of pyrocotton.

The solvent and pyrocotton are mixed in a kneading type of heavy duty mixer consisting of a covered water-cooled compartment in which two shafts bearing curved agitator blades rotate in opposite directions. During this collodizing operation, the so-called stabilizer (e.g. diphenylamine) is incorporated into the mixture.

In pressing, the colloid is subjected to a sequence of preliminary blocking presses, macaroni press and a final blocking press. During these operations the pyrocotton has been changed from a mass resembling light brown sugar to a dense, elastic, translucent, brown or amber substance ready for the final graining and cutting to size. Here again, hydraulic presses are used to force the colloid through steel dies which impart the desired form of a perforated or solid strand of uniform diameter and density. The flexible ropes of powder issuing from the press heads are led over pulleys to the cutting machines which are carefully adjusted to give the exact length and size of grain desired.

The product is now approaching final form as far as shape and appearance are concerned; but there are still several important steps remaining in the process. The grains contain a considerable amount of ether-alcohol solvent which must be removed. This is done in the solvent recovery equipment in which the powder is placed in metal-lined boxes, perforated cars or other drying chambers, while warm air is forced through the material according to a continuous cycle and in a closed system of air circulation. Warmed air containing the solvent is forced over cold coils to condense out the solvent, is reheated and again forced through the powder.

Final drying is accomplishd in a separate operation either by air drying or by the so-called water-dry treatment. In the latter, warm water is kept circulating through the powder for approximately four days to remove the last traces of the solvent. It is then removed and air-dried for about 48 hours. Other devices and modifications of drying procedure are described at some length in the War Department Technical Manual No. 9-2900, pp. 14-16. Detailed attention is also directed to the final blending and storage operations.

CONCLUSION

These processes have been briefly described here in order to emphasize the many chemical engineering operations they involve. It is evident, therefore, that this rapidly developing field offers an immediate and a long-time opportunity for chemical engineers. It has been estimated by the government that the smokeless powder, high explosives and shell-loading plants will require at least 4,000 chemists and chemical engineers for various supervisory jobs and for chemical control. In addition, some 2,000 chemically trained inspectors will probably be required by the Army and the Navy as the munitions program develops. Most of these positions are for the duration of the emergency, but those men in the War Department and in the Office of Production Management who are looking farthest ahead, visualize a permanent organization of key men charged with the responsibility for keeping these plants in efficient condition and capable of immediate use should future emergencies develop.

Speaking before the Army Ordnance Association of New York City on October 8, 1940, William S. Knudsen, now co-director of O.P.M., said: "I need not tell you gentlemen that the powder question was awfully late in getting started and it is of greatest importance at this time that we keep the plants after we get them going. After the last war nearly all the plants were dismantled and no thought was given to the future requirements which might well have been fatal."

Solvent recovery houses such as are being built for each pair of powder lines

Photo U. S. Army Signal Corps

HYDROFORMING
A New Refining Process

D. J. SMITH AND L. W. MOORE* *Pan American Refining Corp., New York, N. Y.*

Chem. & Met. INTERPRETATION

First of its kind in the world, and important to the nation from the standpoint of National Defense is the new hydroforming unit recently completed at the Texas City refinery of the Pan American Refining Corporation. Suitable for producing from low-octane heavy naphtha either high-octane motor car fuel, high-grade aviation gasoline, or a product containing 80 percent aromatics, this plant alone is capable of producing upward of 25 percent of the country's peace-time requirements of toluol.—*Editors.*

WHILE the use of catalysts to promote chemical reactions dates back almost to the beginning of chemical knowledge, it is only within the past five years that catalytic petroleum refining processes have found a wide commercial application in the United States. The most recent addition to this growing family is the hydroforming process, so named because it is a catalytic method for the "reforming" or converting of low-octane to high-octane gasolines at high temperatures in the presence of hydrogen gas.

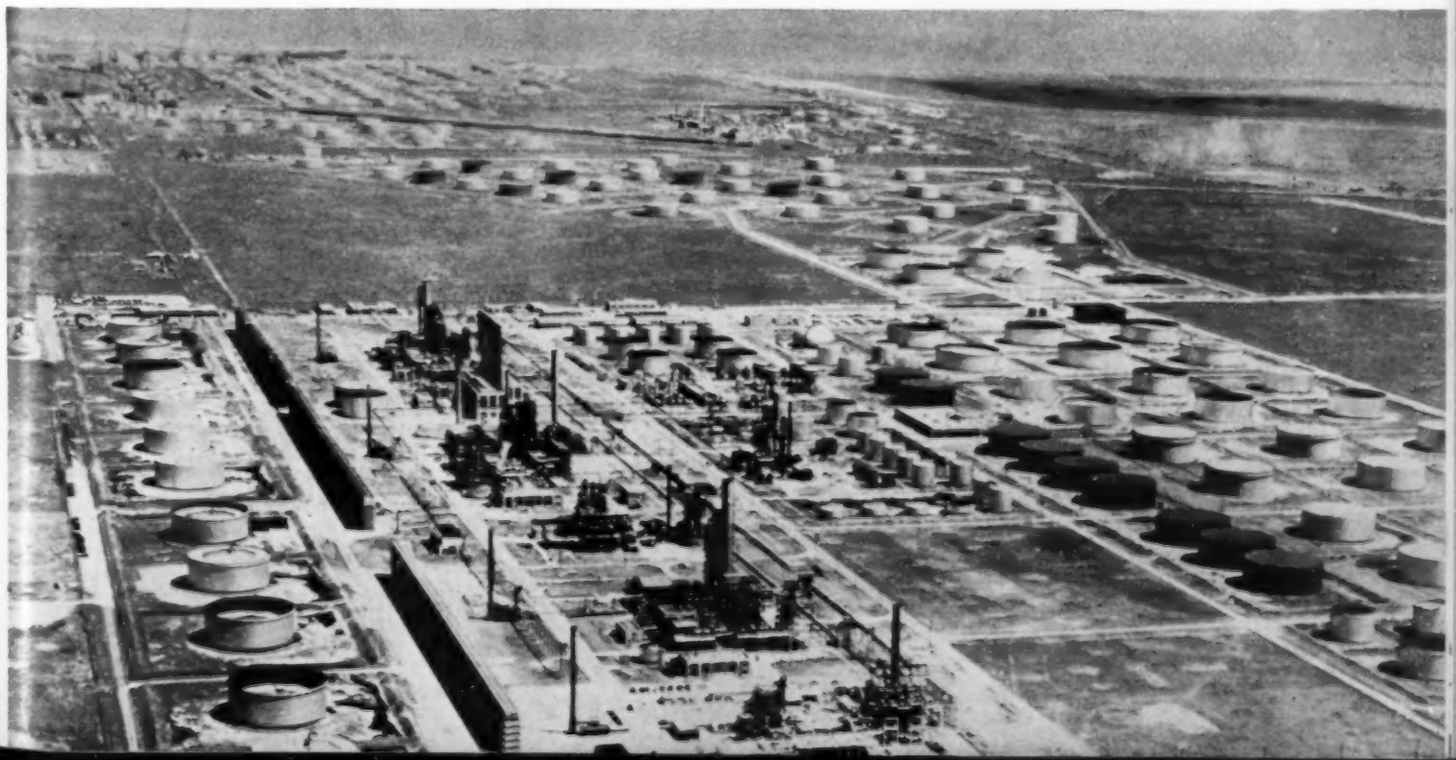
The first commercial hydroforming plant in the world was placed in operation recently at the Texas City, Texas, refinery of the Pan American Refining Corporation. This plant is capable of reforming about 7,500 bbl. per day of 40–45 octane heavy naphtha to an 80 percent yield of about 80 ASTM octane gasoline. The unit is designed to take all of the low-octane heavy naphtha produced from the two largest cracking units in the world (capacity about 40,000 bbl. per stream day each) in addition to small amounts of heavy naphtha produced from miscellaneous crude topping operations. The product from the Texas City plant will be blended into the principal grades of gasoline marketed by the American Oil Company.

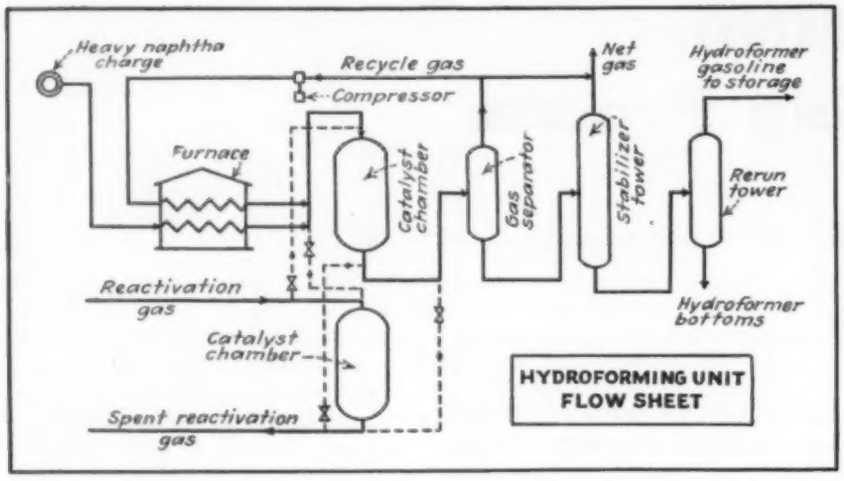
NATURE OF PROCESS

Since the hydroforming process involves carrying on a reaction in the presence of hydrogen, it might appear that this reaction is closely related to the hydrogenation process. This is not the case, however. Hydrogenation reactions involve the addition of hydrogen to hydrocarbon molecules, whereas the net effect of the hydroforming process is to dehydrogenate, that is, to take hydrogen away from the hydrocarbon molecules. Part of the hydrogen gas thus produced is recirculated with the fresh feed in order to control the rate and extent of the dehydrogena-

* Vice President and Technical Assistant respectively.

Texas City plant of the Pan American Refining Corp., location of the world's first hydroforming unit





tion reaction. The most important property of the hydroforming catalyst is that it causes ring-closure of the molecules to occur along with dehydrogenation, so that the final product contains a high percentage of aromatic hydrocarbons and only a small quantity of aliphatic unsaturates. Thus the product is unusually stable and, in the case of the Texas City plant, is blended directly into finished gasoline.

While the design of the Texas City plant presented some difficult engineering problems, the process flow is relatively simple. The fresh feed, consisting of a 40–45 octane heavy naphtha, is preheated by heat exchange with hot reaction products and sent to a combination naphtha and recycle gas preheater furnace. A hydrogen-rich recycle gas stream from a gas separator is also preheated by heat exchange and sent through a separate coil in the preheater furnace where it is heated to a high temperature. The two streams issuing from the furnace are then mixed and sent to the catalytic reactors, which are under substantial pressure.

Hot reaction products leaving the catalytic reactors are partially cooled by heat exchange with cold naphtha feed and other products. They are then cooled to normal temperature and sent to a gas separator. Part of the gas from the separator is used as recycle gas, and the balance goes to the refinery fuel system. The liquid from the gas separator is pumped to a stabilizer tower where the last traces of gas are removed, and then to a re-run tower where a small amount of heavy polymer is removed. The product from the re-run tower is sent to storage from which it is blended into finished gasoline.

During the course of the hydroforming reaction, a small amount of coke is deposited on the catalyst. As the amount of deposited coke increases, the activity of the catalyst gradually decreases, so that it is necessary to remove a catalytic reactor from service periodically and burn off the coke in order to restore catalyst activity.

Burning is done by recirculating flue gas through the reactors, the rate of burning being controlled by adding small amounts of air to the flue gas. Reactivation is carried out at an elevated pressure and at carefully controlled temperatures.

ENGINEERING FEATURES

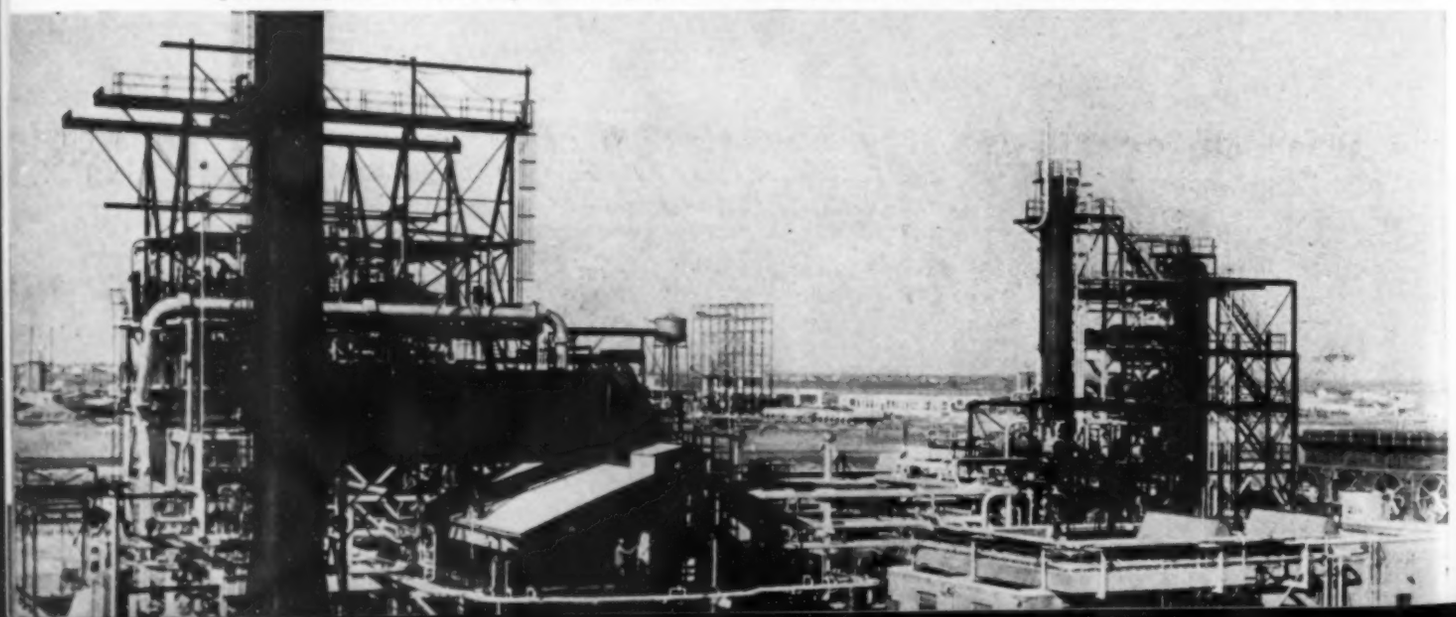
The Texas City plant has two large catalytic reactors which are in service alternately—one being on stream and one off for reactivation at all times.

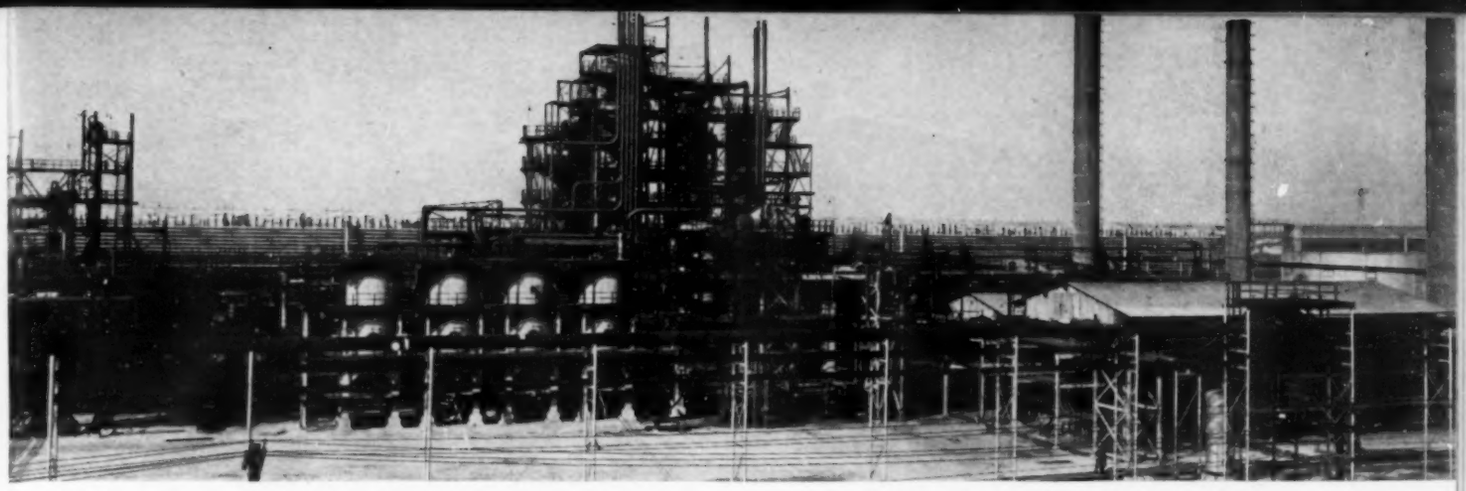
In designing the plant, care was taken to avoid thermal cracking of the naphtha before it contacts the catalyst as such a condition is undesirable because it decreases both the yield and the octane rating of the product and also results in excessive coke deposition on the catalyst.

Design of the recycle gas stream and reactivation systems was a complicated one from an economic standpoint, because for any given octane level, coke deposition is a function of the amount of recycle gas and its hydrogen concentration. Consequently the size of the reactivation system is dependent upon the size of the recycle gas system. This problem, in addition to many others in connection with the design, was made more difficult by the fact that the process development did not go through the usual stages of pilot plant to semi-commercial to full scale design. Practically all of the data used in the commercial design had to be obtained from laboratory operation.

Operation of the reactivation system is entirely automatic and is con-

Hydroforming unit at Texas City, where high-grade aviation gasoline or 5,000,000 gal. per year of toluol can be produced





World's largest crude topping and cracking unit, which furnishes low-octane heavy-naphtha feed to the hydroforming unit

trolled through a time-cycle mechanism. Because of the relatively long reactivation and on-stream periods, the time-cycle mechanism is also used to change conditions in the fractionating towers in order to take care of variations in product quality caused by change in catalyst activity.

The hydroforming process, as installed, is a development of the research organizations of several companies, including primarily the M. W. Kellogg Co., Standard Oil Development Co., and Standard Oil Co. (Ind.). The design of the Texas City plant was carried out by engineers of the M. W. Kellogg Co. in collaboration with engineers of the Pan American Refining Corp. and Standard Oil Co. (Ind.). Construction work was done by the M. W. Kellogg Co. The unit is being operated under patent license from the Standard Catalytic Co., which has important patent rights for this and related processes.

Existing equipment at the Texas City refinery includes three combination crude topping and cracking units and a catalytic gas polymerization plant. The two large units process crude to a wide variety of products, and incorporate thermal naphtha-reforming coils to reform the heavy-naphtha side streams taken from the crude topping systems. The third unit processes heavy crudes containing low yields of straight run gasoline and kerosene to ultimate yields of gasoline and bunker "C" fuel oil. This latter unit has no naphtha reforming coil.

Cracked gases produced from all three combination crudes are sent to the polymerization plant where the unsaturated hydrocarbons heavier than ethylene are converted to a high-octane blending gasoline. The polymerization plant operating in conjunction with the combination units has resulted in very economical reforming operations at Texas City, since it has made possible the recovery of a substantial portion of the high gas loss usually attendant to thermal reforming. However, hydroforming provides a substantially improved yield-octane relationship as compared to thermal reforming in combination with gas polymerization. Since the predominant reaction in hydroforming is dehydrogenation-aromatization, the unsaturated content of the gas is low and is not sufficient to warrant polymerization.

YIELDS AND PRODUCT QUALITY

Although the hydroforming process is sufficiently flexible to produce gasolines over a wide range of octane numbers up to 90 ASTM, the conditions selected for the design of the Texas City plant were those which would produce 80 percent of an 80 ASTM octane number gasoline. Typical charge and product inspections are as follows:

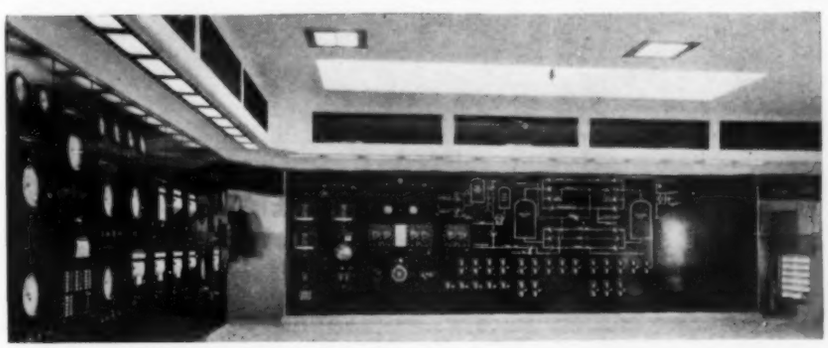
	Charge	Product
Gravity—°API . . .	51.4	51.3
Octane No.—ASTM .	47.2	77.0
Reid V.P.	0.4	8.2
Initial B.P.	222	99
10% . . .	250	174
50% . . .	292	270
90% . . .	367	339
Max. °F. .	436	368

The above inspections show substantial increases in octane number and volatility with only a slight decrease in gravity, thus indicating the presence of aromatics in the product. In fact, analysis shows the product to contain 40 to 50 percent of aromatics. From 15 to 20 percent of the aromatics present are toluene, most of the balance being xylenes and higher products.

While the most important application of the hydroforming process undoubtedly will be to produce high-octane motor car gasolines, there are other features which are of importance to petroleum refiners. The process is sufficiently flexible so that either straight-run or cracked gasolines can be reformed, and in general, the product requires no further treatment to render it suitable for the market.

By changing operating conditions, the hydroforming process can produce a high-grade aviation gasoline, or can be modified to produce a product having upwards of 80 percent aromatics. This latter feature of the process is particularly important from a military standpoint, as it affords a means for substantially augmenting toluene production in this country. The total production of toluene in the United States was 20,000,0000 gallons in 1939, but the toluene content of the product from the Texas City plant alone is equivalent to an annual production of 5,000,000 gallons, or about 25 percent of the total United States toluene production in the year 1939. Total defense needs of toluene are estimated at 65,000,000 gal.

Control board used in manufacture of hydroform gasoline, showing flow diagram



Central Soya Co.'s soybean processing plant at Decatur, Ind., uses Bollman extraction system and expellers

Modern Practice in Solvent Extraction

W. H. GOSS *U. S. Regional Soybean Industrial Products Laboratory*, Urbana, Ill.*

Chem. & Met. INTERPRETATION

Solvent extraction is not a new process by any means, but certain of its newer applications have focussed attention on it. Particularly is this true in the case of soybean oil extraction, which now accounts for about 20 percent of the operations of this industry. The author deals especially with this industry, describing the processes and showing where they are used. He discusses other solvent extraction uses, compares advantages of various solvents, and explains why other oil industries are slow to adopt solvent methods. —*Editors.*

SOLVENT extraction is by no means a new process, although its comparatively recent application in some fields has brought about far-reaching changes in the equipment and methods required for its application to present-day production problems. Modern practice varies according to the nature of the materials to be treated. Garbage, pine stumps, soiled clothing, and oilseeds, to mention but a few, are being handled on a large scale by methods introduced, or at least radically improved upon, within the past decade.

A notable example is the American soybean processing industry which uses hydrocarbons to solvent-extract about 350,000 tons of beans per year, i.e., over 20 percent of its operations. In Table I, estimates which are believed to be reliable show the relative quantities of soybeans processed by various methods during recent years. Current construction work signifies a still further shift toward solvent extraction for the 1940 and ensuing crop years.

Solvent extraction of soybeans, as we know it, did not originate in the United States. Its reduction to practice occurred in the twenties and early thirties and was the natural result of the requirements of Germany and the Low Countries for supplies of edible oils and of protein feeds for their livestock. In Europe, a soybean extraction industry evolved quite logically as the result of (1) the ability of the German trade program to make available plentiful supplies of Manchurian beans, (2) the necessity for recovering the utmost yield of oil in order to meet domestic deficiencies, and (3) the unique adaptability of soybeans to solvent extraction.

It is reasonable in our own country, which normally produces a surplus of edible fats and oils, that soybean processing should develop quite differently. Whereas the continuous press ordinarily produces an oil yield of only 75 to 80 percent, solvent methods recover fully 95 percent of the oil contained in the beans. In Germany, therefore, an incentive existed for development of solvent methods, while, on the contrary, the American industry grew up around machines suitable for a decentralized system of relatively small mills located within the crop-producing areas. In consequence, German solvent extraction practice has, for many years, been considerably ahead of that in this country from both a technical and a tonnage point of view. In the case of continuous presses, i.e., expellers and screw presses, the reverse has been true. Only in very recent years have American manufacturers entered the soybean extraction field and brought about some measure of comparison between the domestic and foreign methods.

As far back as the early twenties, efforts were made to solvent-extract soybeans in this country. A Bollman type of extractor at Norfolk, Va., ran local soybeans in 1924–1925 and attempted to process imported flaxseed, but the project was unsuccessful. Another Norfolk plant used Scott rotary extractors on a variety of oil-bearing seeds, including soybeans and copra, during the same period. About a year earlier, a batch solvent system at Monticello, Ill., also failed. The first successful large-scale operations were those of

*A cooperative organization participated in by the Bureaus of Agricultural Chemistry and Engineering and Plant Industry of the U. S. Department of Agriculture, and the Agricultural Experiment Stations of the North Central States of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.

the Archer-Daniels-Midland and the Glidden companies who installed Hildebrandt type extractors in Chicago during 1934 and 1935. The Glidden plant was destroyed by an explosion in 1935 but was immediately rebuilt with a doubled capacity.

LOCATION OF LARGE PLANTS

At present, there are five solvent systems used in large-scale soybean extraction in this country, two of them being of German and three of American origin. These are installed in eight large (over 50 tons of beans per day) and two small plants. At least one other system is operated on a relatively small scale.

Both soybeans and corn germ are extracted in a Hildebrandt extractor at Clinton, Iowa. Similar equipment is used for soybeans in two Chicago mills. In this system, the extraction step is carried out in a large U-tube through which flaked oilseeds are conveyed, by means of perforated screws, against a counterflow of solvent.

In the Bollman system, extraction is carried out in a vertical series of sieve-bottomed baskets which are carried through the system on a pair of endless chains. Flaked soybeans or other oleaginous materials are charged into the baskets and are sprayed with solvent during their passage through the extractor. Such installations are in operation on soybeans at Decatur, Ind., and at Decatur, Ill.

A similar arrangement of working parts is used in the French Oil Mill Machinery Co.'s process. An installation has been made at Louisville, Ky., for extracting soybeans.

The Allis-Chalmers extractor is a vertical cylindrical column containing a central rotating shaft fitted with a series of horizontal slotted plates. Stationary scraper arms cause the solid material to fall from one slowly rotating plate to another, descending against an upward stream of solvent. An extractor of this type at Cedar Rapids, Iowa, processes soybeans, and until recently there was also one at Evansville, Ind. One was also installed at Peoria, Ill., for recovering corn oil from dried distillers' grains.

The Kennedy extractor uses a number of four-bladed paddle wheels to propel the solid material through a horizontal chamber against a counterflow of solvent. An apparatus of this type is under construction at Hershey, Pa., for the extraction of cocoa butter to be used in soap and other industrial products. This method of operation is also used in the solvent extraction system currently offered by the Vulcan Copper & Supply Co.

American supplies of theobromine are obtained from the residual cake remaining after the solvent extraction of cocoa butter from cacao beans. Until recently, the cacao residues were obtained from Europe where the beans are solvent-extracted

Table II—Estimated Total Capacities of Installations of Various Types of Continuous Solvent Extraction Systems, in all Parts of the World

(Basis: short tons per 24 hours)

System	Oilseeds or oilseed press cakes: World capacity	Oilseeds or oilseed press cakes: U. S. capacity
Bollman (German)	3,100	750
Hildebrandt (German)	2,200	430
Fauth (German)	800	0
Allis-Chalmers (American)	170	170
French (American)	130	130
Ford (American)	75	75

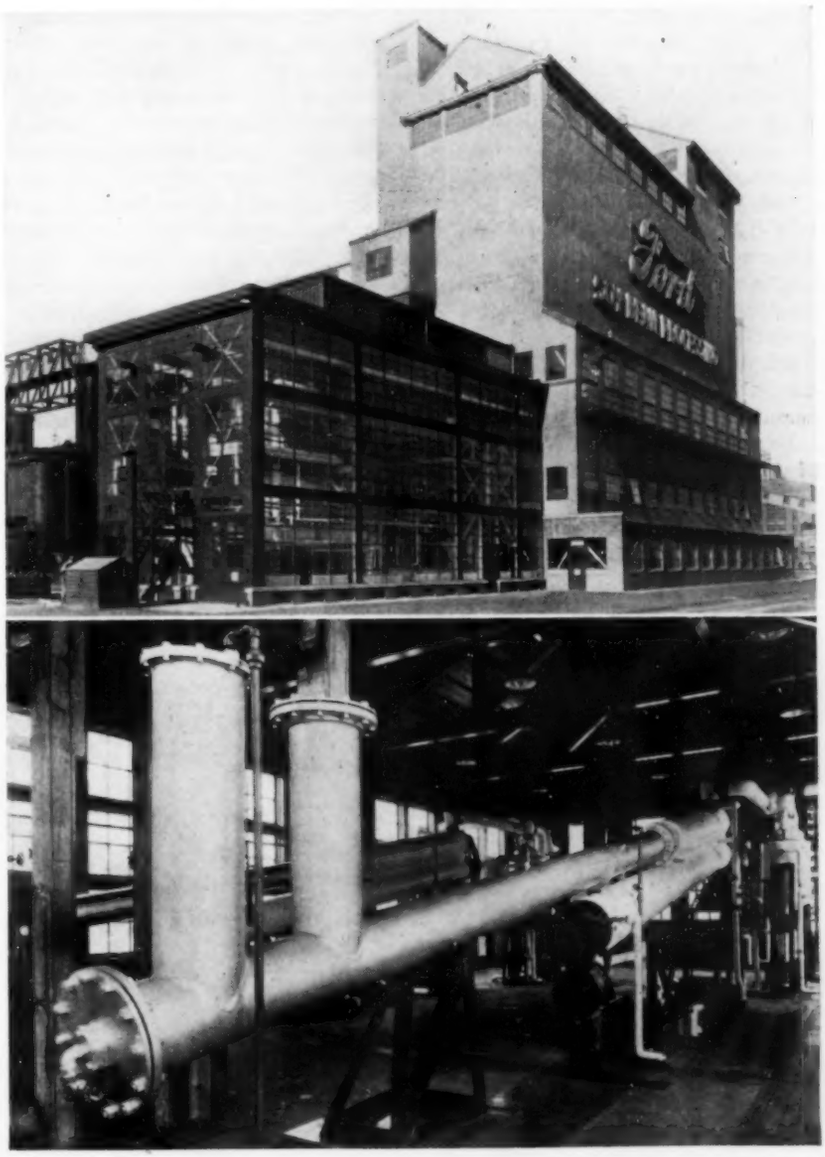
Table I—Soybeans Processed by Expeller, Solvent, and Hydraulic Methods

(Estimates based upon data compiled by Bureau of the Census in cooperation with U. S. Regional Soybean Industrial Products Laboratory, January 1941)

	Crop year (October to October) 1939 Tons	1939 Percent	1938 Tons	1938 Percent	1937 Tons	1937 Percent	1936 Tons	1936 Percent
Expeller	1,274,016	74.4	967,173	72.2	637,532	70.1	422,800	68.5
Solvent	346,055	20.2	214,161	16.0	155,591	17.1	81,604	13.2
Hydraulic	92,081	5.4	158,093	11.5	116,167	12.8	114,136	18.5
Total	1,712,152	100.0	1,339,427	100.0	909,290	100.0	618,540	100.0

Ford Motor Co.'s soybean mill at the River Rouge plant

Two small soybean extractors in Ford's soybean mill at Saline, Mich.



in batch equipment. Imports of this material have been interrupted by the war, and this country has accordingly been facing a serious shortage of theobromine. To cope with the situation, there has been put into operation during the past few weeks another large continuous solvent extraction plant located in the Hampton Roads area and designed especially for handling cacao beans. Ample supplies of the byproduct, theobromine, are thus assured.

The enthusiasm which ran high in the early 1930's for the "industrialized barn" type of soybean extractor has become more rationalized, and at least two technically satisfactory types of extractors have resulted. The Ford Motor Co. developed one consisting of an inclined tube housing an internal screw which conveys beans upward against a countercurrent solvent flow. It is now being used in one large and two small plants, all owned and operated by Ford.

There has evolved, from work done by Iowa State College and by the R. & H. Chemicals Department of E. I. DuPont de Nemours & Co., an extraction system which, in simple terms, might be described as a Ford extractor running backwards. It is designed for solvents heavier than soybean oil, specifically trichloroethylene; hence it operates with an upward flow of solvent and downward flow of soybeans in the main extraction tube. There are no commercial installations at present.

Besides the strictly continuous systems for solvent extraction, there are in operation a great many types of batch extractors. A number of manufacturers produce complete and extremely compact units, automatically operated for the dry cleaning industry. Batch extractors of various types are also used for garbage degreasing, rendering meat scraps, and similar operations.

Estimates of the total installed capacities of several systems for continuous countercurrent extraction of vegetable oils, throughout the world, are given in Table II. These figures lend some measure of proof to the statement, made earlier, that German practice has a substantial lead over the American industry, from the standpoints of tonnage and experience.

OTHER EXTRACTION USERS

Not a few proponents of solvent extraction indulge in an indoor sport which consists approximately in the following elementary computation:

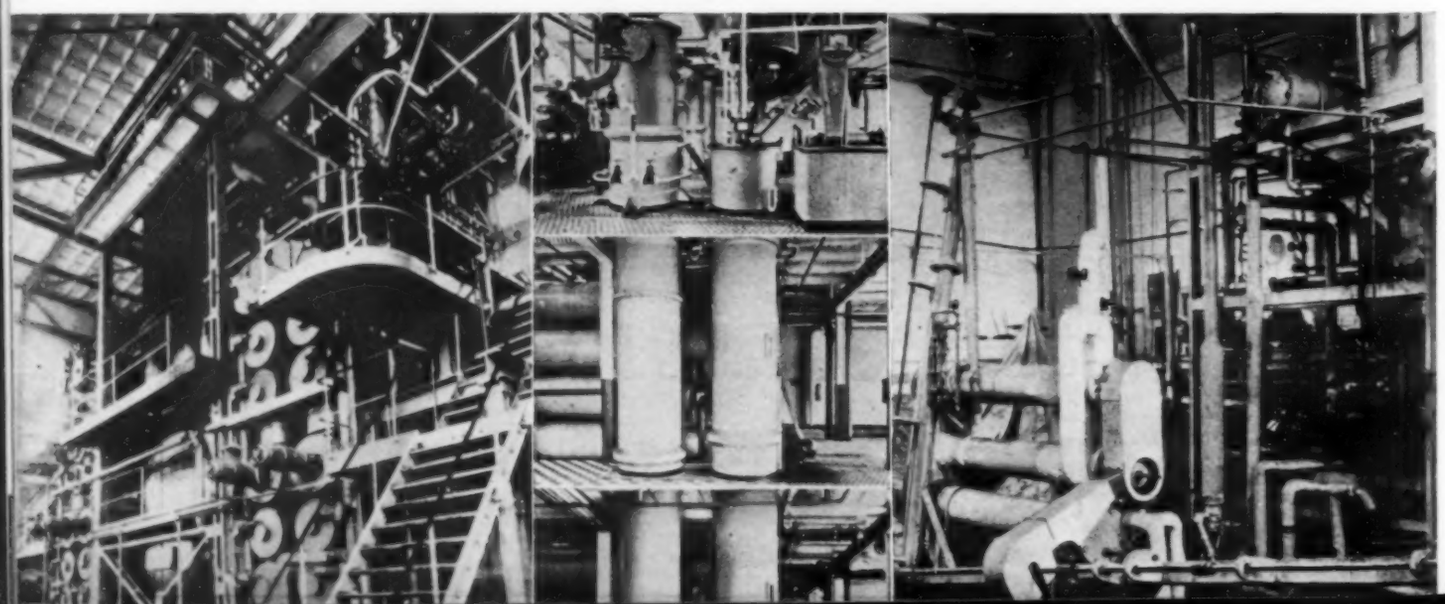
$$AD(B-C)-E = \text{"Gravy"}$$

where: A = tonnage of cottonseed crushed annually in the United States; B = hypothetical oil yield per ton of seed, using a hypothetical solvent extraction process; C = actual oil yield by present pressing methods; D = market price of cottonseed oil; and E = a small, probably optional, correction for meal shrinkage. The "gravy" awaits the enthusiast who succeeds in converting the entire cottonseed industry to solvent extraction. The same arithmetical diversion is similarly applied to flaxseed, copra, peanuts, etc., but the American vegetable oil industry would have solvent-processed these materials on a large scale long ago if the problem were that simple.

Although the soybean industry is a most progressive one, it is not entirely progressiveness that has caused it, almost alone of the domestic oilseed industries, to turn to solvent extraction. The technological problems incident to solvent extraction of other oilseeds are infinitely greater than they are in the case of soybeans. For example, the latter can be easily rolled into thin, firm flakes which retain their structure even after the oil has been leached from them. Cottonseed, flaxseed, and others form flakes which disintegrate when treated with oil solvents, and the result is a powdery pulp which cannot be handled in ordinary solvent systems. The miscella or solvent-oil solution which results from such extractions, likewise, contains mucilaginous materials which defy treatment by the usual methods. These and similar obstacles to solvent extraction of other oilseeds can and, no doubt, will be solved, but it is quite unlikely that any major developments will be instigated prior to their solution.

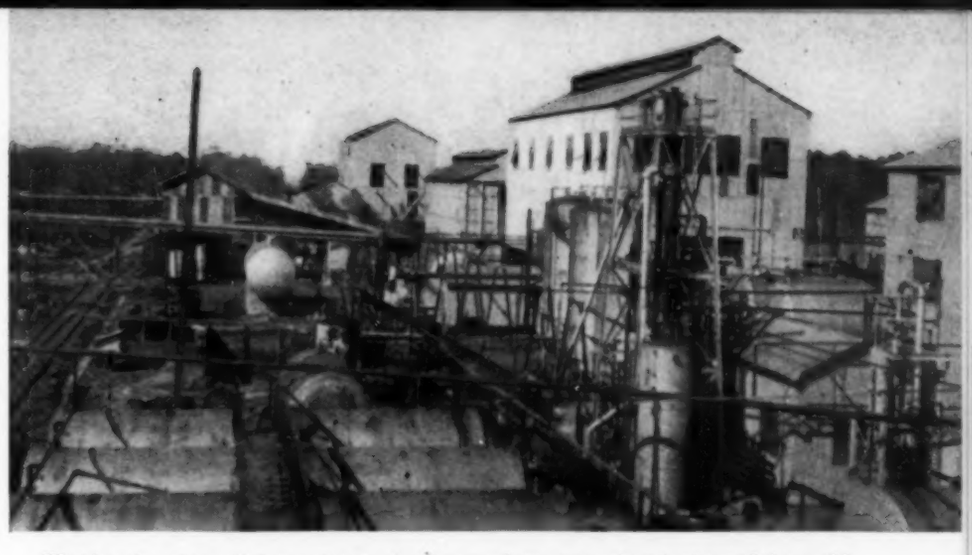
The list of industries now employing solvent extraction is a long one, and only a few besides those already described can be mentioned as examples. Caffeine is being extracted from coffee by means of trichloroethylene and other chlorinated hydrocarbons. Isopropyl alcohol is used to extract zein, an alcohol-soluble protein material, from the effluent remaining after the settling operation in wet corn milling. Riboflavin is being extracted from distillers' grains with butanol. Wheat germ oil and wheat germ flour are being produced by extracting wheat germ with hydrocarbon solvents. From a tonnage standpoint, perhaps the most spectacular solvent extraction business is the naval stores industry which uses

Left: Huge soybean mill of Hansa-Muehle, A. G., Hamburg, Germany, using Bollman system; center: Hildebrandt extractor; right: experimental soybean extractor built by R. & H. Dept. of E. I. duPont de Nemours & Co., Niagara Falls, N. Y.



hydrocarbon solvents to recover wood-rosin, turpentine, and dozens of terpene derivatives from over 1,000,000 tons of old pine stumps taken yearly from cut-over land.

One of the South's new industries, tung oil production, sees opportunities for increasing its output by resorting to solvent extraction for recovering last traces of the valuable drying oil from the press cake, after most of the oil has been removed by expellers or screw presses. In this connection, the extraction of press cakes is practiced extensively in Europe. At Magdeburg, Germany, an extractor processes peanut and rapeseed press cakes. Peanut press cakes are also handled in continuous extractors at Bordeau, Marseilles, and Dunkerque, in France, and in Baesrode, Belgium. The last-named installation also processes soybeans as well as press cakes from palm-kernels and copra. A similar mill at Uerdingen, Germany, extracts castor bean press cakes.



Wood rosin, pine oil, turpentine and other products are solvent-extracted from old pine stumps by Crosby Naval Stores, Inc., at Picayune, Miss.

SOLVENTS

The choice of a solvent for a particular extraction depends upon a number of factors. First, it must be a good solvent, i.e., it must penetrate into the cell structure of the solid material and dissolve out the soluble substances, and only the desired soluble substances. It must be easily removable from both the miscella and from the residue, leaving both in marketable condition. This is a most important qualification.

The production of vegetable oils consists in considerably more than the unit operations of extraction, distillation, evaporation, drying, etc. The individual operations must in many cases be carried out in such a manner that the products meet the exacting specifications of the food industries, and this requires rigid adherence to the practices with which only those having long experience in the fat and oil trade can claim thorough familiarity. For example, the solvent must be completely removed from the oil without raising its temperature above a rather indefinitely defined maximum, and the operations must be carried out in equipment fabricated only from those materials which experience has shown to be free from any tendencies toward contaminating the oil with traces of certain metals. The presence of minute amounts of copper, as well as numerous other metals, is fatal to the stability of refined soybean oil. In edible oil production, the corrosion problems incident to the choice of a solvent and materials of construction revolve not around damage to the equipment but rather around the damage caused by metallic contamination of the product.

In large-tonnage solvent extraction of vegetable oils, solvent losses usually amount to 0.5 to 1.0 percent of the weight of raw materials processed. The loss is a very real item of expense, particularly if the operation requires one of the dollar-a-gallon type of solvents. This factor, almost alone, accounts for the rather general use of relatively low-priced hydrocarbon solvents where at all possible, despite hazards connected with their use.

Within recent years, petroleum companies have stepped up their production of special solvent naphthas having particularly narrow boiling ranges, low evaporation residues, excellent stability, and other properties required of good solvents. Above all, they are cheap. However, when improperly handled, they can be extremely dangerous. The soybean industry has witnessed a number of tragic proofs of the explosibility of these solvent vapors when mixed with air. One disaster killed eleven workers and completely demolished an extraction plant.

Although most of the oil companies produce a line of solvent naphthas, the soybean industry has confined its solvent purchases to a very few of the refiners. The most commonly used naphtha is essentially a normal hexane fraction boiling from 146 to 158 deg. F. It is easily evaporated, leaving a residue of only 0.0004 percent by weight. In Germany, as well as in most European plants, a gasoline boiling from 160 to 195 deg. F. is used.

Apparently there is only one commercial soybean extraction plant in the world using any solvent other than a petroleum cut. The exception is the Manchuria Soybean Industry Co., in Dairen. Here, the so-called hot alcohol process is used with a battery of rotary extractors to process approximately 100 tons of soybeans per day. The solvent is 99.8 percent ethanol, dehydrated at the plant, and it is used at 80 deg. C. under pressure. The resultant miscella, when cooled to room temperature, separates into two layers, i.e., an alcohol-rich and an oil-rich phase. The alcohol-rich layer is re-used, and the oil layer is separated by distillation. The advantages of the process lie chiefly in the ease with which byproducts, such as phosphatides, sugars, and saponins, may be recovered. The American market for these items, it seems, is not now sufficient to warrant the use of the alcohol extraction process in this country. Considerable research has been directed toward the use of methanol-benzene and ethanol-benzene mixtures for soybean extraction in cases where phosphatide recovery is of importance. In the late 1920's, the plant of the Hansa-Muehle, A. G., at Hamburg operated for a short time using such mixtures.

Still other solvents have been considered for soybean extraction. Benzene was used in some of the early installations. The chlorinated hydrocarbons have received a great deal of attention, and equipment designed for trichloroethylene is now on the market. Fluorinated hydrocarbons also possess desirable properties. Among the advantages claimed for the halogenated hydrocarbons, the most noteworthy is the decreased fire hazard as compared to hexane. Among the disadvantages, the most serious appears to be the present relatively high price.

Methanol and ethanol are examples

of a considerable group of solvents which display partial miscibility with glyceride type fats and oils at low temperatures. In the two-liquid region, as a rule, the oil dissolved in the solvent-rich layer is more highly unsaturated, i.e., it has a higher iodine number, than the undissolved glycerides in the oil-rich phase. This suggests a possible method for separating the drying and nondrying constituents present in semidrying oils, soybean and corn oils for examples. Sulphur dioxide was proposed for this purpose over 50 years ago, and several patents cover its use.

The fat and oil economy of the United States at the present time lends particular significance to the suggestion that the drying-oil fractions be removed from semidrying oils. Over-supplies of lard, cottonseed oil, and other edible fats and oils have created a serious surplus problem, while at the same time it has been necessary to import large amounts of all types of drying oils. The situation is further aggravated by the rapidly expanding production of soybean oil, over 80 percent of which also enters edible channels. The need for diverting soybean oil into the drying oil trade is being recognized by many research organizations, and the selective action of those exhibiting partial miscibility with soybean oil appears to be a most promising approach. Besides sulphur dioxide, such solvents as furfural, ethyl lactate, nitroethane, and many others have been studied, and it is safe to predict that the fat and oil industry will soon be operating large-scale equipment for liquid-liquid extraction in addition to the previously described oil-seed extraction systems.

PERFORMANCE AND COST

The cottonseed and flaxseed crushing industries in this country grew up around the hydraulic press, and because of the enormous capital invested in hundreds of hydraulic mills, there has not been any marked shift to other processing methods. The amount of hand labor required in a batch process of this type is necessarily large, and it results in a comparatively high operating cost. In cottonseed mills, where negro labor is employed exclusively, the conversion costs are said to be in the order of $5 to $8 per ton of seed. Typical operation results in a meal containing 5.0 to 5.5 percent oil.

The American soybean industry has grown up around the more modern expeller or screw press. It requires far less hand labor and the conversion cost is accordingly lower than in hydraulic processing. The residual meal contains 4.0 to 5.0 percent oil. Solvent-extracted meal contains only 0.5 to 1.0 percent oil, and since cottonseed and soybean oils sell for from 4 to 7 cents per pound compared to approximately 1.0 to 1.5 cents per pound for the meal, the increased return from solvent processing is evident.

Solvent-extracted soybean oil, as produced in large and properly equipped plants, is handled interchangeably with and in the same channels as expeller and hydraulic oils. Solvent-extracted soybean oil meal, before reaching the market, is ordinarily cooked in the presence of a large excess of moisture. This treatment makes it more digestible and yields a meal that is fully as acceptable to the feed trade as expeller and hydraulic meals. Since the market acceptance of the products and the overall conversion costs appear quite comparable for large-scale continuous pressing and solvent extraction processes, the advantages seem to be in favor of the latter because of the greater return from the oil. Installation costs, however, are about twice those of expeller or screw press installations. For rough estimating, it can be assumed that a large soybean extraction plant, including the bean preparation machinery and the oil and meal treating equipment, costs $2,500 per ton of daily capacity. The total conversion costs are claimed by the manufacturers to be in the neighborhood of 10 cents per bushel of beans ($3.33 per ton of beans or approximately 1 cent per pound of oil).

The idealized picture of a farmer extracting the oil from his own soybeans is still upheld by many as part of an industry-on-the-farm plan, although this view is not shared by most of those familiar with the edible oil markets and the economics of operating a large solvent plant. In the opinion of most authorities, the practicability of extremely small solvent units has not been demonstrated, where the products must be marketed in competition with the large mills. However, the small installations which have been made have helped greatly by pointing out to the public the fine work done in industrializing the soybean.

As in most industrial undertakings, solvent extraction is employed by the soybean industry only as one step in the production of finished products. In this specific instance, the finished products are mixed feeds, soy flour, industrial proteins, shortening, margarine, salad oils, paints, varnishes, and miscellaneous products. It is rather unusual for a soybean processing company to engage only in the operation of converting soybeans into oil and meal. Instead, such mills are generally operated in conjunction with feed mixing plants, oil refineries, and similar enterprises. Solvent extraction, then, is but one of the many tools of a great young industry based upon the production of edible and industrial products from an important agricultural crop.

In conclusion, an apology might be in order for exemplifying the soybean industry, to the exclusion of a dozen or more others, in describing the development and present status of one class of solvent extraction. No discrimination has been intended, but it is emphatically suggested that engineers contemplating the use of solvent extraction in any form would do well to investigate the contributions which soybean processors have made to the science.

Editor's Note: In its recent 1939 statistical releases the U. S. Census of Manufactures for the first time made available information on the expenditures for plant and equipment in the animal and vegetable oil field. The data do not include the manufacture of lubricants, nor cooking and salad oils. The table below has been derived from the Census figures, to highlight the trends more clearly. The figures apply only to those processors who actually reported capital expenditures for plant and equipment. Note the high capital expenditure of the soybean industry per establishment and per dollar value of product. With only 9 percent of the total number of establishments, this industry nevertheless made 34 percent of the expenditures for plant and equipment in this field.

	Total for Group	Cottonseed Oil, Cake, Meal, and Linters	Linseed Oil, Cake, and Meal	Soybean Oil, Cake, and Meal	Essential Oils	Fish and Marine Oils, Cake, Meal	Vegetable and Animal Oils, n.e.c.
Average value of products per establishment.....	$630,000	445,000	2,930,000	1,045,000	1,280,000	200,000	880,000
Average expenditure for plant and equipment per establishment.....	$14,650	9,200	29,000	56,500	9,400	7,900	16,400
Average expenditure for plant and equipment per dollar value of product.....	2.32c.	2.07c.	0.99c.	5.41c.	0.73c.	3.95c.	1.86c.

What Soybean Processing Costs

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Chem. & Met. INTERPRETATION

The article below is a brief abstract of a paper presented by the author, under the title of "Continuous Solvent Extraction of Vegetable Oils," before the vegetable oils symposium of the A.S.M.E., held in Atlanta, April 2-3. A complete transcript of the paper will appear in the May issue of *Mechanical Engineering*.—Editors.

USE of solvent extraction in the United States dates back to about the time of the Civil War. However, only recently have great strides in this field been made and the first large scale continuous solvent extraction plant did not make its appearance in this country until about nine years ago. Since then, six others are known to have been established, mostly for soybean processing, with an aggregate capacity of 1,350 tons per day. Two others will probably be in production shortly, raising the total daily capacity to about 1,550 tons.

American processes in some respects have developed quite differently from the European processes, probably due to the tendency of American processors to force their machinery to the ultimate.

A solvent extraction plant, in simplest terms, must mill the feed to a suitable condition for extraction, extract the oil by use of a suitable solvent, remove and recover the solvent from the extracted residue, and separate and recover the solvent from the solvent-oil mixture (miscella). How this is done in a representative flowsheet is shown diagrammatically below.

The extractor is a vertical compartment type with plates or disks properly spaced to prevent bridging. Scrapers on a central shaft regulate the downward velocity of the flakes and provide the necessary agitation. Such a system has been shown to require but 0.6 lb. of solvent per pound of material treated, including the "hold-up" in the extracted material going to the dryers. Both screws and Redler conveyors can be adapted successfully to elevating the material above the solvent level for discharge. The bulk of the solids can be separated by screens. Part of the remainder can be settled out, and the rest removed, together with phosphatides or other "foots," by centrifugation, or filtration, or both, *after distillation*. Lecithin can be recovered if desired. The oil so produced is of premium grade.

Table II — Approximate Comparative Cost of Solvent Extraction and Mechanical Expression

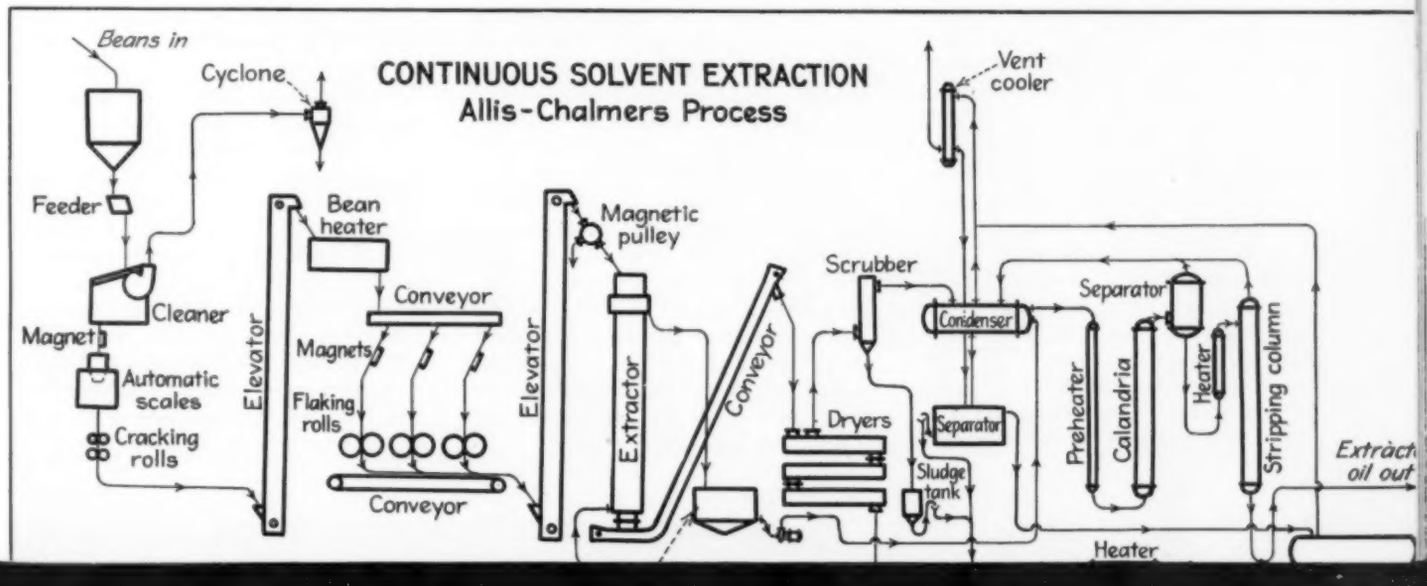
	Solvent Extraction	Mechanical Expression
Cost of beans, per bu.	$0.90	$0.90
Oil yield, lb. per bu.	10.8	8.4
Oil recovery per bu., $ at 5c. per lb.	0.54	0.42
Meal yield, lb. per bu.	48	50.4
Meal recovery per bu., $ at $25 per ton	0.60	0.63
Total value of products	1.14	1.05
Gross margin per bu.	0.24	0.15
Processing cost per bu.	0.092	0.085
Net profit per bu.	0.158	0.065

Table I gives a method for predicting processing costs on soybeans. For comparison, Table II lists approximate data on both solvent extraction and mechanical expression processes.

Table I—Processing Cost Analysis

(Based on a solvent extraction plant properly designed for handling 120 tons per day of soybeans. The following performance characteristics are to be expected: yield of oil, on No. 2 yellow beans, average year, 18 percent; solvent loss, 2 gal. per ton; power required, 20 kw.-hr. per ton; steam required, 1,100 lb. per ton; water required, 1,600 gal. at 70 deg. F. per ton; meal and oil commercially free of solvent; oil in extracted meal, 1 percent or less.)

Item of Expense	Investment	Yearly Charges
1. Land, int. at 5%	$3,000	$150
2. Building, int. at 5%	25,600	1,280
3. Building, depr. at 5%	.....	1,280
4. Building, maint. at 2%	.....	512
5. Office and furn., int. at 5%	3,000	150
6. Office and furn., depr. at 5%	.....	150
7. Office and furn., maint. at 4%	.....	120
8. Machinery, piping, wiring, etc., installed, int. at 5%	144,800	7,240
9. Depr., 10% of item 8	.....	14,480
10. Maint., 0.8c. per bu.	.....	9,600
11. Solvent inventory	1,920	96
12. Taxes, $30 per M on 70% valuation, on items 1, 2, 5, 8, 11	.....	3,750
13. Ins., $20 per M on 90% valuation on items 2, 5, 8, 11	.....	3,160
14. Steam, 35c. per M lb.	.....	13,860
15. Water, 5c. per 100 cu. ft.	.....	3,850
16. Power, 1.33c. per kw.-hr.	.....	9,576
17. Solvent loss, 12c. per gal.	.....	8,640
18. Labor, 3 men per shift, at 60c. per hr.	.....	12,960
19. Superintendent	.....	3,500
20. Totals, prep. and extraction	$178,320	$94,354
21. Cooling, grinding and sacking machy., installed, int. at 5%	11,960	598
22. Depr., 10% of item 21	.....	1,196
23. Maint., 0.2c. per bu.	.....	2,400
24. Oil storage tanks, installed, 50,000 gal., int. at 5 %	4,375	219
25. Depr., 5% of item 24	.....	219
26. Maint., 2% of item 24	.....	88
27. Oil inv., 1 wk. at 5c. per lb.	15,120	756
28. Meal inv., 2 wk. output at $25 per ton	33,600	1,680
29. Taxes, $30 per M on 70% valuation on items 24, 27, 28	.....	1,366
30. Ins., $20 per M on 90% valuation on items 21, 24, 27, 28	.....	1,211
31. Power, 6 kw.-hr. per ton at 1.33c.	.....	2,873
32. Labor, 2 men 1 shift at 60c. per hr.	.....	2,880
33. Totals, meal and oil handling	$65,055	$15,486
34. Processing cost per bu., preparation and extraction	.....	$0.079
35. Processing cost per bu., meal and oil handling	.....	0.013
36. Total processing cost per bu.	.....	$0.092



Investing in The "Chemicals": The Industry

ROLAND P. SOULE *Tri-Continental Corporation, New York*

Chem. & Met. INTERPRETATION

Herewith Dr. Soule, a chemical engineer who couples to an unusual degree sound chemical technology and good business sense, presents the first of two articles on the investment aspects of the chemical industry. In the present article the industry is oriented historically, economically, and financially in relation to the economy as a whole. Next month Dr. Soule will suggest ten reasons why chemical earnings command a premium in the stock market.—*Editors.*

THERE is an old French proverb which says, if translated literally, "The more things change, the more they remain the same." The only thing that doesn't change is change itself. Change is continuous not only in technology, but in political thought, in economic relationships, in customs, and in buying habits. What is important in one generation may be unimportant in the next. And it is a brave man who dares say that the world is approaching stability. The rate of change is not slowing down. Its tempo is accelerating, and the old is giving way to the new at a rate faster than at any other time in our history. It may not be apparent exactly where we are going. It is clear, however, that we are moving rapidly on our way.

What has this to do with investments? Everything. Investments deal with the future. When we buy a bond or a share of stock, our concern is with what happens to it in the future. If it fares poorly next year, we may dislike even to recall that it did well last year. The statistics of past performance are only dead figures. In the difficult job of deciding what we should buy today, the really vital thing is to catch some glimpse of what tomorrow will be.

Now, ouija boards and crystal balls being what they are, there is only one practical answer. It is to be sought by the same methods as those used in technical research. When the answer lies beyond the reach of laboratory experimentation, it is sometimes possible to draw a line through all points that can be plotted by experiment, and then to project the curve into the unknown. In investment analysis the method is the same. We study what we know of the past, and then seek to project our experience into the future. This approach is at best hazardous and open to the possibility of great error. It is easy to detect trends, but how shall they be appraised? It is clear that we must look further back than the immediate past if we are to have any confidence in our judgment. We can see where we are and sense the direction in which we are moving only if we occasionally broaden our perspective and view our present position in relation to investment history as a whole.

Transportation—The first publicly-financed enterprises of the modern type dealt largely with transportation. In our own country, the nineteenth century provided many excellent examples. It was the period of our greatest geographical growth and rugged individualism was at its height. Road construction was not the exclusive function of governments, and many highways were promoted by individuals who sold toll-road bonds to the public. Next came the period of canal construction, which flourished between 1800 and 1850. Canals soon gave way to railroads and from Civil War times to the beginning of the present century the railroad ruled the investment market. The capital required to build these roads was enormous, and large bond issues were floated.

Before the present century very few Americans of modest means purchased common stocks. The equity in the great railroad systems was still pretty much family-owned and controlled by the original promoters. To be sure, the N. Y. Stock Exchange was incorporated in its present form in 1869, and many rail stocks were traded there at that early date. But, it was not until 1889 that public participation in the stock market was broad enough to make it worth while to keep statistics on its performance. The first record is the famous "Dow-Jones" average; i.e. the average price of the 20 most active stocks, as calculated daily by the Dow-Jones Co., publishers of the *Wall Street Journal*.

Of these 20 original stocks, 18 were rails. Only one of the list has remained continuously in the average in the following 51 years to date, and that is New York Central. By 1930 the rail stocks had fallen from over 80 percent to about 14 percent of the market value of all stocks listed on the N. Y. Stock Exchange. The last 10 years have further cut their proportion to 7 percent. The rails still account, however, for about half of the total dollar value of the bond market, apart from government, state, and municipal obligations.

The Utilities—The two original Dow-Jones stocks of 1889 which were not rails were what we now call utilities. One was Western Union Telegraph, and the other Oregon and Transcontinental, which soon changed its name to its present title of North American Co., the pioneer electric utility holding company. North American did not stay popular very long, and in 1894 gave way to American Sugar Refining Co., the first industrial stock to be included in the market averages. Two years later the non-rail stocks as a group were considered to be of sufficient public interest to have an average of their own. In 1896 the 12 most popular companies of this type were selected. American Sugar and North American were transferred to the new list, which contained nine industrials and three utilities.

However, water, gas, and electric utilities steadily gained in favor. The security of their business and the steady rise in their earnings had a strong investment appeal. They enjoyed their period of greatest prosperity in the twenties, and in 1929 were split from the industrials to have a Dow-Jones average of their own. But they never again approached the peak of their 1929 popularity. Because of rate reductions, taxes, government regulation and government competition, they have declined steadily in market importance. The gas and electric utilities still rank second to the rails in the bond market, but their common stocks today account for only about 8 percent of the total value of all common stocks listed on the N. Y. Stock Exchange. This is little more than half of their contribution 10 years ago. They have recently been nosed out by the telephone, telegraph, and radio companies, which have risen from eight to nine percent in the same period.

The Industrials—Industrial stocks have grown from relative insignificance at the turn of the century to a position where they are now responsible for nearly three-quarters of the value of all listed stocks. This spectacular gain within 40 years has been due largely to the expansion in the unit size of American industrial enterprises. As small proprietorships and partnerships grew, they gave way to corporations. With the increasing number of large corporations, the small stockholder became for the first time an important unit in the economic scheme of things.

Change has made itself felt not merely in the ascendancy of the industrials and in the accompanying decline first of the rails and more recently of the utilities. To an even greater extent, it has been reflected in the ebb and flow of the fortunes of the individual companies comprising the industrial group. Of the various stocks that were in the Dow-Jones non-rail average in the nineties, how many names are familiar today? Very few modern investors have even heard of American Cotton Oil, Distilling and Cattle Feeding Co., Central Leather, American Spirits, U. S. Cordage, Pacific Mail, and Standard Rope & Twine. General Electric was in the 1896 list, but the oldest steel company was Tennessee Coal & Iron. U. S. Steel did not appear until 1901, when it was organized by J. P. Morgan.

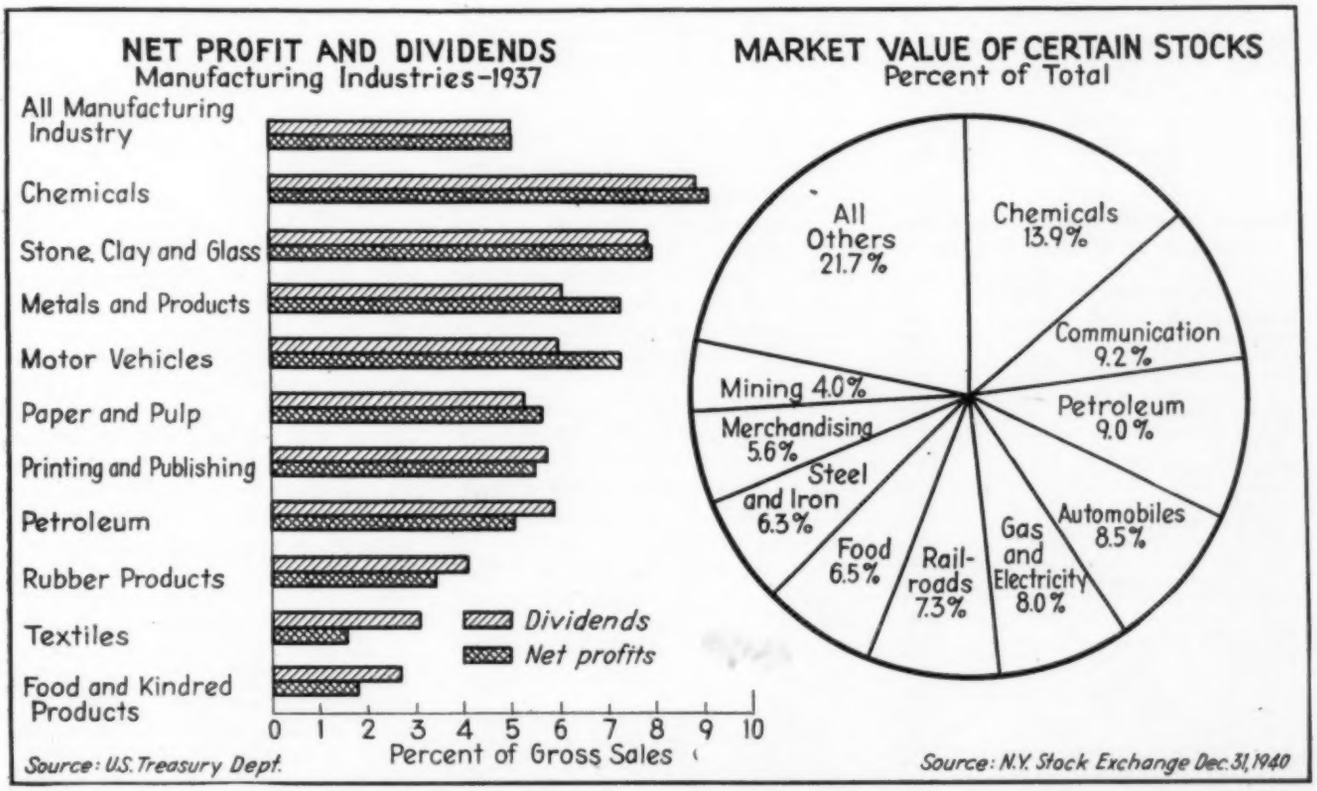
The stock market was temporarily suspended in 1914 upon the outbreak of the war. When it was re-opened, the original list of 12 industrial stocks was expanded to 20. In October 1928, in the great bull market, the number was further increased to 30. The composition of this list from year to year has been a picture of the changing American scene.

The first chemical stock in the average was duPont in 1924. It was not actively traded, however, and gave way one year later to U. S. Realty, a popular issue in the period of rising real estate prices. Allied Chemical in 1925 was the next chemical to enter the averages, and has remained there continuously for the past 15 years. Union Carbide was added in 1928, and duPont rejoined the list in 1935. Texas Gulf Sulphur was included from 1928 to 1932, being superseded by International Shoe.

This story of the replacement of one stock by another may convey a false impression. The market averages of the industrial stocks are not operated at random. There are now approximately 700 different industrial stocks listed on the N. Y. Stock Exchange, and the problem is to have an index of only 30 issues fluctuate in value pretty much as the total of the entire 700. This requires constant adjustment and readjustment. It is significant that the enlarged list of 30 "Dow-Jones industrials" has had to undergo 26 changes in the 13 short years of its existence from 1928 to date.

THE CHEMICAL INDUSTRY

How does the chemical industry stand against this background of constant change? What is its past, its present, and its prospective future? It is a large order to attempt



to answer these questions. Four simple observations, however, can safely be made:

1. Historically, it is old in years but recent in major growth;
2. It is extremely heterogeneous in composition;
3. It is already impressively large in magnitude;
4. It is dynamic in promise of future expansion.

Historical Perspective—The chemical industry presents a number of paradoxes. First, it did not enter its period of greatest growth until it had already reached a venerable age. The 300th anniversary of the founding by John Winthrop, Jr. of the first chemical company in this country was celebrated in 1935. Yet it was not until after the World War that the chemical industry began to take an important position in our economy as a whole. As a result, chemical securities have been traded in volume only in recent years, although many present chemical enterprises antedate the automobile and steel industries, and a few are older even than the railroads. The reason is fairly obvious. In their earlier days these pioneer chemical firms were not large enough to command public attention. Also, they were family-owned for the most part, and grew by reinvestment of earnings. Unlike the railroads, for example, they did not have to sell their securities to the public to finance extensive programs of plant enlargement.

Thus, Table I shows that 22 of the 26 leading chemical companies listed on the N. Y. Stock Exchange* have been traded only in the last 25 years and 12 in the last 15 years. Against the long panorama of investment history, therefore, the "chemicals" are relative newcomers.

Table I—Principal Chemical Companies Traded on N. Y. Stock Exchange

(Approximate date of listing)

Eastman Kodak	1905
Tennessee Corporation	1909
U. S. Industrial Alcohol	1911
Int'l Agricultural Corp.	1914
Mathieson Alkali	1917
Freeport Sulphur	1919
Davison Chemical	1920
Air Reduction	1920
Allied Chemical	1920
Texas Gulf Sulphur	1921
DuPont	1922
Virginia-Carolina Chemical	1922
Atlas Powder	1922
Columbian Carbon	1923
Union Carbide & Carbon	1926
Westvaco Chlorine	1929
United Carbon	1929
Hercules Powder	1929
Monsanto Chemical	1929
Commercial Solvents	1929
American Agric. Chemical	1931
Newport Industries	1931
Dow Chemical	1937
Victor Chemical	1938
National Cylinder Gas	1939
National Oil Products	1940

Table II—Corporate Sales and Profits [1] U. S. Manufacturing Industries in 1937

($000,000 omitted)

	Gross Income [2]	Gross Sales [3]	Net Profit [4]	Dividends [5]
Metals and products				
Iron and steel	4,209	.....	188	.....
Miscellaneous machinery	1,654	.....	118	.....
Hardware and tools	1,396	.....	134	.....
Electrical machinery	1,250	.....	140	.....
Metal building materials	1,012	.....	50	.....
Other metals and products	5,828	.....	446	.....
Total metals and products	15,349	14,835	1,076	902
Food and kindred products	10,880	10,653	183	268
Petroleum	5,288	4,852	246	285
Motor vehicles	4,754	4,632	339	278
Textiles	4,534	4,417	71	138
Chemicals				
Acids, compounds, etc.	1,054	.....	173	.....
Paints, varnishes, pigments, carbon black, naval stores	567	.....	31	.....
Drugs, oils, soaps, chemicals, not elsewhere classified	2,413	.....	165	.....
Fertilizers	188	.....	7	.....
Total chemicals	4,222	4,063	376	360
Printing and publishing	2,439	2,191	121	128
Clothing and apparel	2,250	2,184	9	24
Forest products	1,930	1,864	54	70
Paper and pulp	1,888	1,838	105	97
Liquors and beverages	1,822	1,778	118	106
Stone, clay, and glass	1,537	1,484	119	117
Leather and its manufactures	1,332	1,313	16	30
Tobacco	1,302	1,280	106	109
Rubber products	1,107	1,079	37	45
Mfg. not elsewhere classified	1,839	1,781	93	88
Total manufacturing	62,473	60,244	3,069	3,045

[1] Computed from Statistics of Income; U. S. Treasury Department.
[2] Includes dividends, interest, and other non-operating income.
[3] Gross sales, less returns and allowances.
[4] Net profit (after taxes) of corporations with income, less deficit of corporations with no income.
[5] Includes both cash and stock dividends.

Definition and Scope—The second paradox of the chemical industry is that it is no industry at all in any real economic sense. The various companies of which it is comprised have no bond of a common product as do the oil and copper industries. Neither do they serve a common market, as do the automobile, farm equipment, and office equipment industries. Instead, the only characteristic shared by all chemical companies is the common usage of a chemical process in production or refining. Today, however, chemical processes or products touch in some respect almost all manufacturing operations that are not limited simply to mechanical fabrication.

Even among the companies that are quite generally called "chemical," there is an extraordinarily high degree of diversification. This diversification extends to raw materials, processes, products, and markets. It is an important feature, and has created a type of corporate competition which is unique. For example, the three largest chemical companies (duPont, Union Carbide and Allied Chemical) really compete directly with each other only in a limited number of items out of their total lines. Imagine a similar situation in the oil or automobile industries! There is keen competition in chemicals, of course, but it is widely scattered along many fronts. Each individual chemical enterprise serves a different combination of the country's basic industries—i.e., activities that constitute industries in a true economic meaning. Thus, each company is a different "package," so to speak, of varying amounts of steel, textiles, automobiles, agriculture, etc. And the larger the company the more nearly does it thus become a cross-section of all industry.

This observation is significant from an investment standpoint. Some managers of funds have hesitated to increase their commitment in chemicals for fear of "over-concentration in a single industry." This fear appears unwarranted. Such concentration, of course, would not be on products or markets but on a broad type of manufacturing operation.

Magnitude—The exact magnitude of the chemical industry is largely a matter of definition. The wider the scope of the activities included, the more imposing are the statistics. It is of some help, however, to follow the practice of the Bureau of Census

* American Cyanamid Co. is the largest of several publicly-owned chemicals which are not listed on the "Big Board"; it has been traded on the Curb Exchange since approximately 1917.

and to divide it into two parts: the chemical *product* industry and the chemical *process* industry. The former includes only those companies which make acids, alkalies, and all the compounds which have technical names and which are sold chiefly to other manufacturers. The second and broader group includes paints, varnishes, carbon black, naval stores, drugs, soaps, fertilizers, etc. (but not cellophane, rayon and petroleum products).

In 1937, the most recent year for which complete data are available,* the firms manufacturing strictly chemical products had a gross income of a little over $1,000,000,000, while the larger group of chemical process companies had revenues of nearly $3,200,000,000 (see Table II). The sum of $4,200,000,000 for the two groups accounted for 6.8 percent of the total income ($62,473,000,000) of all manufacturing industries in this country. The smaller chemical product group alone contributed only 1.7 percent. These figures are exclusive of the petroleum industry, which was responsible for 8.5 percent of the total. The N. Y. Stock Exchange includes in its classification of chemical companies not only manufacturers of strictly chemical products but firms engaged in the production of carbon black, naval stores, fertilizers, and photographic materials. The average investor concurs in this viewpoint, and his picture of the chemical industry is chiefly the group of 26 stocks which are listed in Table I. The Exchange, however, also includes the soap, glass, drug, salt, and vegetable oil companies.

It so happens that in 1937 the sales of these 26 publicly-owned "chemical" companies totaled about $1,000,000,000, or very nearly the same figure as that for the chemical product group of Table II. While a reasonable similarity is to be expected, the closeness of this correlation is the result of compensating errors. On the one hand, the 26 companies obviously did not manufacture all of the chemical products sold in 1937. On the other hand, however, there were included in their sales such non-chemical materials (Census definition) as rayon, cellophane, paints, lacquers (duPont), coke, gas (Allied Chemical), flashlights, dry cells, ferro-alloys (Union Carbide), film and cameras (Eastman Kodak).

* In order to obtain data on profits and dividends, the "Statistics of Income" compiled by the U. S. Treasury Department were used. Industry classifications are similar to those of the Census, but totals are based on sales and not on production. Only preliminary figures for 1938 are now available.

Despite many inconsistencies, therefore, the census taker and the investor arrive at substantially the same sales figure. It may appear small. In fact, the third paradox of the chemical industry is that its magnitude can be considered impressive when it accounts for scarcely 1¾ percent of the country's total output of manufactured goods. Its gross revenues in 1937 were exceeded by those of several individual companies alone in other industries (Standard Oil of N. J., $1,300,000,000; U. S. Steel, $1,400,000,000; and General Motors, $1,600,000,000). There are three important reasons, however, why the chemical industry is much more important in the stock market than its modest sales figures would suggest:

1. The transition from private to public ownership is relatively far-advanced (contrast the situation in foods, textiles, construction, and merchandising where only a small part of the total business is conducted by companies listed on the Stock Exchange);

2. Chemical sales earn higher-than-average profits (chemical products accounted for 5.6 percent and entire chemical group 12.2 percent of total manufacturing profits in 1937; see Table II);

3. Chemical earnings command higher-than-average market prices (at the end of last year the 26 "chemical" companies represented 16.5 percent of the market value of all manufacturing companies listed on the N. Y. Stock Exchange; see Table III).

Table III—Market Value of All Stocks Listed on N. Y. Stock Exchange, Dec. 31, 1940

($000,000 omitted)

Chemical	Market Value	Percent of: Mfg.	Total
26 Companies*....	4,245	16.5	10.4
Other.....	1,407	5.5	3.5
Total chemical..	5,652	22.0	13.9
Petroleum.....	3,693	14.4	9.0
Automobile.....	3,481	13.6	8.5
Food.....	2,633	10.3	6.5
Steel and iron:.....	2,568	10.0	6.3
Misc. machinery.....	1,530	6.0	3.8
Electrical equip.....	1,431	5.6	3.5
Tobacco.....	1,401	5.4	3.4
Aviation**.....	605	2.4	1.5
Farm machinery.....	597	2.3	1.5
Bldg. materials.....	474	1.8	1.2
Paper and publishing.	421	1.6	1.0
Rubber.....	334	1.3	0.8
Office equipment.....	276	1.1	0.7
Textiles.....	258	1.0	0.6
Leather and shoes...	158	0.6	0.4
Garment mfgrs.....	39	0.2	0.1
Misc. mfgrs.....	110	0.4	0.3
Total mfgrs.....	25,631	100.0	63.0
Communication.....	3,732		9.2
Gas and elect.....	3,261		8.0
Railroads.....	2,985		7.3
Merchandising.....	2,269		5.6
Mining.....	1,636		4.0
Finance.....	834		2.0
Amusements.....	264		0.6
Shipbuilding.....	102		0.3
Hotels, real estate...	14		...
Shipping services....	7		...
Total.....	40,765		100.0

* See Table I; includes about $480,000,000 of duPont's equity in General Motors.

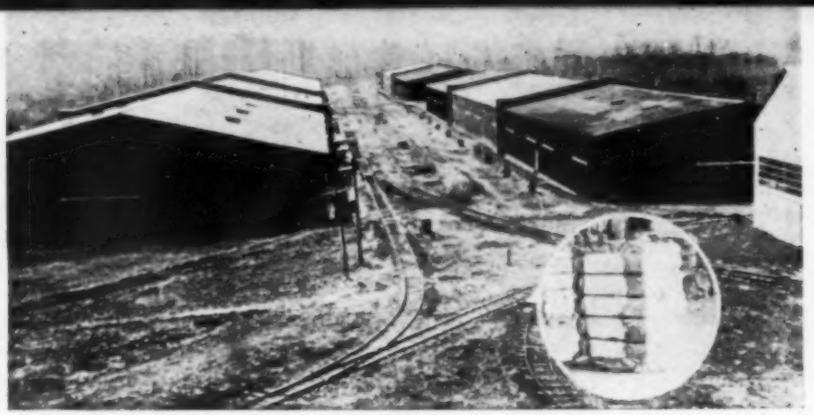
** Both manufacturing and operating companies.

An inspection of Table III indicates that the chemical group has the largest market value of any of the various classifications. Even excluding the soap, glass and drug manufactures, the restricted list of 26 "chemicals" outranked the communication stocks, the utilities and the rails. This is a relatively new development. Ten years ago the chemicals stood only fifth. Eight years ago they were second to the oils. Since 1934 they have been first.

Future Growth—The mechanics by which chemical companies have been able to expand sales and achieve a more important position are fully as significant as mere statistics of their growth. The very difficulty of defining the chemical "industry" indicates what is still taking place. The partly chemical industries are progressively becoming more chemical, while certain industries which have been almost completely non-chemical in the past are now beginning to adopt chemical operations or to consume chemical products. Examples are numerous: petroleum, soaps, rubber, textiles, paper, paints and varnishes, building materials, and even agriculture. More chemists are now employed outside than within the chemical industry itself. Natural commodities have been replaced by synthetic materials, and new products without any counterpart or precedent in nature have been created.

This last statement is of utmost importance. The trend of the chemical companies is not the same as that of industry as a whole. Our entire economy has been slowing down. It is evolving into a more mature, European type in sharp contrast with its youthful characteristics of the past. But certain parts of it will continue to grow by feeding on the others, even if the whole gains little or remains relatively static. Time alone will prove which industries are to be found in this favored group. New products, new methods, and new customs are certain to appear. They will be hazards to many companies. Yet they are the very life-blood of the chemical industry. In fact, it is only through more and greater change that its frontiers can be advanced still farther.

Purifying Cotton Linters



A 12-months supply of raw linters must be stored

JAMES A. LEE
Managing Editor, Chemical & Metallurgical Engineering

Chem. & Met. INTERPRETATION

Cotton linters are a raw material used in the production of such products as smokeless powder, rayon, lacquers, film, plastics, artificial leather, and dynamite. Chemical engineers have so greatly improved the purification and bleaching operations that finished linters with optimum characteristics desired in a raw material for the production of each of these materials can be obtained. The process in general use in the industry, rather than that of any particular company, is described here.—*Editors.*

"SECOND-CUT" COTTON LINTERS are purified and used for production of lacquers, gun cotton, rayon and other cellulose base products. They are cheaper than the first cut but as high in cellulose content, and offer the additional advantage of being relatively free of field trash which adheres to the longer fibers of the other cut. However, a smaller amount of longer-fibered chemical cotton is purified for those consumers whose equipment makes its use seem requisite.

When selecting raw linters for chemical purposes it is necessary to consider such factors as staple, color, foreign matter (boles, stems, sand, etc.) hull particles, analysis and origin. Final selection depends upon the use to which the purified linters will be put; each user has his own specifications. On arrival at the mill linters are carefully graded and stored.

A cotton linters purification plant represents a much larger investment in structures and equipment than is generally known. It consists of several large warehouses for storing the many thousands of bales of cotton linters consumed annually, one or more purification buildings in which linters are purified and bleached, a cotton drying building in which loose or bulk linters are dried and baled for shipment, and a cotton sheeting building where paper-making equipment converts linters into pulp in sheet form. Finished product warehouses, laboratories and office buildings are also essential parts of the layout. A power house is located some distance from the operating buildings in order to avoid the possibility of cinders or coal dust contaminating the product during processing.

Since the season during which cotton seed oil mills operate is quite short—usually about five to six months—sufficient linters must be bought and stored at the plant to provide for customers' orders for at least a year. They are stored in warehouses of concrete and steel construction.

The purification process consists of removal of impurities by both mechanical and chemical means. The latter is a temperature-pressure treatment with caustic soda which converts the hulls and other foreign matter into a soluble form so that they can be removed by washing. This is followed by bleaching. The chemical cotton is then conveyed to the drying department if the product is to be shipped in loose form, or to the sheeting department if the product is to be put in the form of pulp sheets. The process requires about 20 hours.

The processing equipment is divided into a number of separate units, each consisting of a digester, wash tub, two bleach tubs, storage tanks and blending equipment.

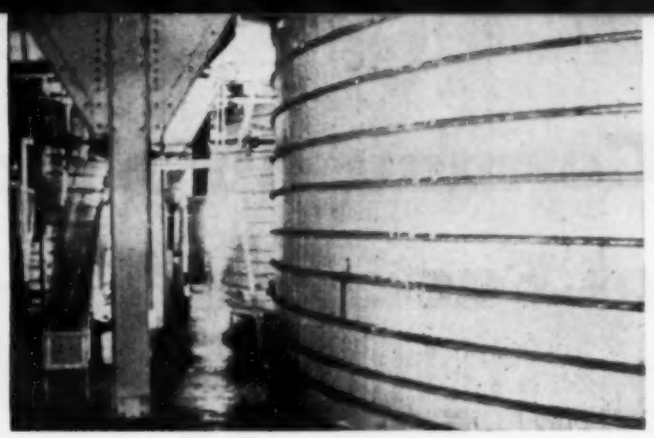
The number of bales of the brownish cotton that will be required for a batch are placed on a conveyor which carries them to a breaker, a rotating cylinder with bronze (used to prevent sparks) spikes known as a "devil duster." Here the bales of cotton are knocked apart, mechanically cleaned and fluffed up.

At the end of this machine further separation of heavy particles occurs when linters are picked up by air and blown to the top of the building. Air is separated from linters taking with it light dust and fine particles of an objectionable nature, while cotton drops into a conveyor operating above the series of digesters. At this point cooking liquor is added. It is previously prepared in the weigh tank by drawing sufficient 50 per cent caustic soda from storage for a batch, diluting and heating to boiling. This cooking liquor thoroughly wets the linters with hot caustic while they are being conveyed to the digester.

The digester is a vertical vessel fitted with a removable top for charging. It is charged with a 10 to 1 ratio of solution and cotton. The air is first displaced and the pressure raised to from 30 to 100 lb. and held at this point for a period of from two to six hours depending upon the desired viscosity of product. Cooking conditions as well as strength of solutions are carefully controlled.

When the treatment is completed the valve on the bottom of the digester is opened and the steam pressure blows the entire contents up through the cyclone separator above the digesters, where steam and stock are separated. The latter falls into the steel wash tank. The spent cooking liquor is drained off the linters through a valve in the bottom of the tub and is discharged into the sewer. The alkali is too diluted to be recovered economically by dialysis or other means.

Storage tub of chemical cotton



Large wooden tubs are used for blending

The cooked linters are gray to a light yellow color which varies in shade with the original material and the cooking conditions. Linters are thoroughly washed with water at ordinary temperature to remove all caustic. During the washing the stock is stirred vigorously in order to hasten the operation. Approximately 30,000 gal. of water per ton of linters are used for the washing at this point.

Cotton, now purified and free from all oil and waxes, passes by gravity from washtubs to bleaching tanks. The latter are wooden stave construction, fitted with vertical agitators and perforated false bottoms to permit drainage of spent bleach liquor and to simplify the washing operation.

Bleaching of the cooked linters is a carefully controlled operation and the method used closely resembles that in use for bleaching wood pulp. In both cases the practice of multiple stage bleaching is found to be more satisfactory than a single stage bleach as the cellulose fibers must not be attacked.

Chlorine, either as such or in the form of sodium and calcium hypochlorite, is used as the bleaching agent. Careful control of pH, time, temperature, and concentration of chemicals in each bleaching step is necessary to produce a cellulose of full white color with no degradation of cellulose. Sulphuric acid is used as a souring agent and an oxalic acid solution is used after bleaching to reduce the iron content. Thorough washing of the cellulose follows each bleaching treatment. All chemical solutions are tested before using and accurately gaged before being applied to the cellulose.

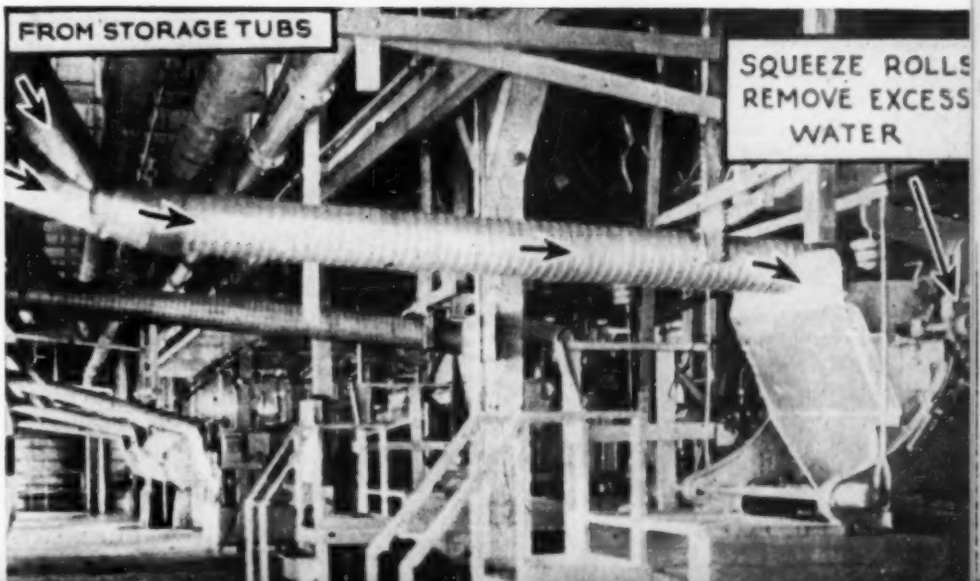
The bleached linters flow into a storage tank and from there to the drying or sheeting department, depending upon the ultimate use of the product.

Linters destined to be converted into viscose rayon are pumped to the sheeting department. Several batches are mixed in an elaborate continuous blending system of a series of large wooden tanks. From the last of these tanks enough linters are withdrawn at regular intervals to fill the hollander beaters. Each tank in the series from the last to the first is replaced from the preceding tank by this small volume. This is done to assure uniformity of product. A special beater "brushes out" the stock. It is further refined in a jordan and then goes to a storage chest. The refined linters are made into sheets on a fourdrinier paper machine. The temperature of the drying rolls of the machine is kept low so that the cellulose will not be harmed. The accurate control of moisture content of the finished sheets is important. Sheets are cut according to the size specified by each customer, though the thickness of sheet has become standardized at 0.04 inch. Sheets are baled, weighed, wrapped in kraft paper and sent to storehouse or shipping platform.

Linters to be shipped loose and later acetylated, nitrated or otherwise treated are pumped from storage tubs in the purification plant to the drying department. In a concentration of about 0.5 per cent cotton in water the slurry is passed over a series or rifflers, where removal of foreign matter of a higher density than water is effected. Rubber squeeze rolls wring out excess water, leaving about a 50 per cent moisture content. From here chemical cotton enters a picker which pulls it apart so that lumps are eliminated, permitting greater ease of drying. The loosened cotton now falls onto a travelling screen bed which carries it through the tunnel dryer in which the moisture is removed by a current of hot air, the temperature depending upon the use for which the cotton is to be put, cellulose acetate cotton requiring a lower temperature than most other grades. The tunnel dryer ordinarily used has a capacity of approximately 4,000 lb. per hr.

On leaving the dryer the cotton is conveyed to rotary screens which remove fine cotton dust. Magnetic pulleys remove any metallic particles that may remain. It is then compressed in balers, wrapped in heavy kraft paper, weighed, picked up on transfer skids and sent to the storehouse or to the loading platform.

Battery of drying units showing wet ends. Rubber squeeze rolls wring out excess water. Photographs supplied through courtesy of Hercules Powder Co.



German Air Raid Defense of Factories

CURT WACHTEL *formerly director German Institute of Industrial Hygiene*

Chem. & Met. INTERPRETATION

The author has been employed by the German and Russian Governments as an expert on defense of factories against air raids, sabotage, and other wartime destructive agencies. These nations have learned much regarding the location of chemical, smokeless powder and other defense plants, where to store raw and finished materials, what type of building construction to adopt. We in the United States might profit from their experience.—*Editors.*

PREPARATIONS for air raid defense in Germany virtually began on the day following the Armistice of Nov. 11, 1918, and gradually came into the open long before the Nazi system was established in power. In 1932 the Institute of Industrial Hygiene and Occupational Diseases, in cooperation with the leading enterprises of chemical, electrical and metal industries, released a moving picture dealing with the protection of such plants against explosives and gas bombs. A great number of private companies offered special devices for gas protection, standard shelters and shelter equipment. The training of the civil population in air defense became general. Understanding and consciousness of the problem were deeply rooted in the minds of the general public.

The creation of such an atmosphere brought home to the leaders of industry the necessities for the investment of funds in the construction of new factories which would be protected against air raids.

It is evident that the development in Germany was almost the opposite of what is going on in this country at the present time. German engineers had more than a decade at their disposal for experimenting. Chemical engineers of this country have to prepare themselves immediately for the task. Lectures on military science were obligatory for German students at engineering schools and were given by experts who had practical experience in the field or had been leading in research. There are only a few such lecturers in this country. American engineers, therefore, have to make good for their lack of information by their commonsense and natural intuition for the rapid solutions of practical problems.

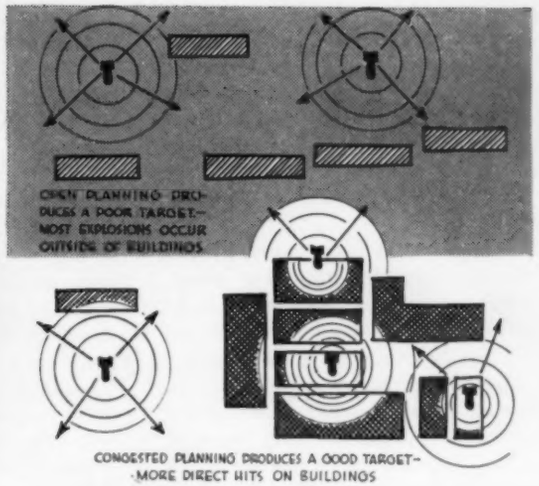
The first gas attack took place in April 1915, under the direction of Fritz Haber. Since the time of that event, the German chemical industry has never lost sight of the importance of defense. And just a year later the most essential centers of the industry in Western Germany were exposed to air raids. The first defensive reaction was a flight of those plants that could afford to move from the border districts into the central parts of the country. New plants such as the Leuna works and the tetralin plant were located in the most central parts of Germany. The first filling station factory for mustard gas shells was built in a suburb of Berlin in the Spring of 1917. There it could not be attacked by allied airplanes; yet, it was reached by British agents who succeeded in blasting the whole structure after the first 1,200 field gun shells had been filled.

Reconstruction of chemical and other industries in Soviet Russia after the first World War and the Russian Civil War was also carefully planned in view of the conditions prevailing in military aviation at that time. All of the defense industries were located in the most central parts of that vast country. The rule was that they had to be at a distance of at least 600 kilometers (about 373 miles) from the border. With regard to the range of bombers, this location was still relatively safe a few years ago. It would not be so today. On the average the most important Russian defense industries are much farther from the frontiers and still fairly well protected by their distance from the border. Other industries such as mining and oil fields can in no case freely select their location. Baku and Far Eastern petroleum industries of Soviet Russia are well within range of enemy bombers and were at no time safe.

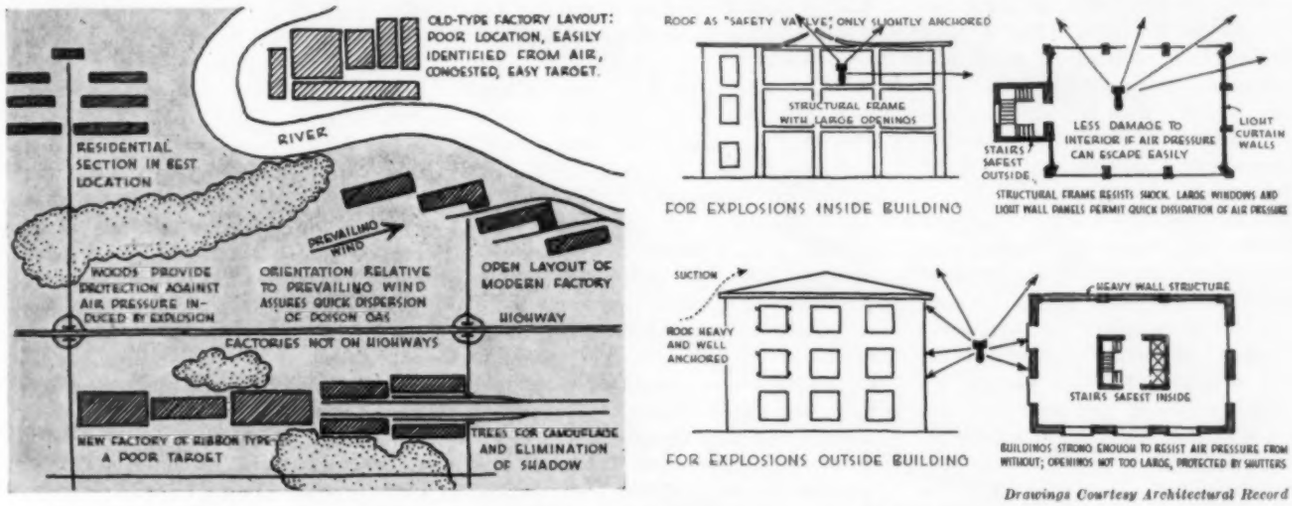
It has been reported that the American Douglas B19 can fly to Europe and back carrying 36,000 lb. of bombs. If the enemies of the European countries possess a number of such airplanes, they are able to reach every point of that continent however remote it may be. At least in Europe, Asia and Africa, no place between the North Pole, Capetown and the Campbell Islands is safe from air attack. As it is even today technically possible to attack from the air every point of the globe, it is obvious that the danger will increase in the near future with the mass production methods employed in the manufacture of airplanes.

These European experiences illustrate the fact that the retreat of industries into remote parts of the country is of limited value only. Even for a country like Soviet Russia which is practically a continent, the retreat of the industry into the central parts of the country offered only a temporary solution of the problem. For smaller countries such as Germany, France and England, it was only possible to consider a reasonably even distribution of industrial units over wide areas, instead of the accumulation of industries in a few

Camouflaged cooling towers somewhere in Europe. To raiding parties at 5,000 ft. or more they pass unnoticed


OPEN PLANNING PRODUCES A POOR TARGET—MOST EXPLOSIONS OCCUR OUTSIDE OF BUILDINGS
CONGESTED PLANNING PRODUCES A GOOD TARGET—MORE DIRECT HITS ON BUILDINGS

Military considerations may alter factory planning. Structures scattered, or in lines, form poor targets


OLD-TYPE FACTORY LAYOUT: POOR LOCATION, EASILY IDENTIFIED FROM AIR, CONGESTED, EASY TARGET.
RIVER
RESIDENTIAL SECTION IN BEST LOCATION
PREVAILING WIND
WOODS PROVIDE PROTECTION AGAINST AIR PRESSURE INDUCED BY EXPLOSION
ORIENTATION RELATIVE TO PREVAILING WIND ASSURES QUICK DISPERSION OF POISON GAS
OPEN LAYOUT OF MODERN FACTORY
HIGHWAY
FACTORIES NOT ON HIGHWAYS
NEW FACTORY OF RIBBON TYPE—A POOR TARGET
TREES FOR CAMOUFLAGE AND ELIMINATION OF SHADOW
ROOF AS "SAFETY VALVE," ONLY SLIGHTLY ANCHORED
STRUCTURAL FRAME WITH LARGE OPENINGS
FOR EXPLOSIONS INSIDE BUILDING
LESS DAMAGE TO INTERIOR IF AIR PRESSURE CAN ESCAPE EASILY
STAIRS SAFEST OUTSIDE
LIGHT CURTAIN WALLS
STRUCTURAL FRAME RESISTS SHOCK. LARGE WINDOWS AND LIGHT WALL PANELS PERMIT QUICK DISSIPATION OF AIR PRESSURE
SUCTION
ROOF HEAVY AND WELL ANCHORED
HEAVY WALL STRUCTURE
STAIRS SAFEST INSIDE
FOR EXPLOSIONS OUTSIDE BUILDING
BUILDINGS STRONG ENOUGH TO RESIST AIR PRESSURE FROM WITHOUT; OPENINGS NOT TOO LARGE, PROTECTED BY SHUTTERS

Drawings Courtesy Architectural Record

The poor target suffers fewer direct hits, and requires different precautions against damage, than the good target. In the chemical industry it has been found useful in many instances to divide the manufacturing process into small units

large centers. For a great number of reasons, this solution could not be realized in Germany. In the European democracies the problem was not considered because there was no adequate national planning of air raid precautions prior to the outbreak of this war. Nor was there any personality or agency capable of attempting the solution of a national problem of such giant dimensions and with manifold ramifications reaching into all branches of national production.

While recent experiences in Britain have proved that air raid precautions cannot be accomplished without some centralized effort at coordination of the varied activities, it is a general rule to be derived from observations in all fields, and in all countries, that decentralization should be carried out to the greatest possible extent.

The air raid defense of a chemical plant may be divided as follows:

1. An existing plant can in most cases be left where it is European experience indicates. A new plant should be located where it requires the minimum of transportation for raw material and end products, where the geological and geographical conditions are most favorable to bomb-proof, gas-proof and fire-proof construction methods, and where the economic factors are most favorable.

2. Air raid precautions must include all risks at the same time: protection against high explosive bombs, incendiary means, noxious gases and fifth-column activities. While compromises on partial solutions may be unavoidable in practice, one must keep in mind that partial solutions are highly uneconomic, because they do not guarantee the safety of production for the duration of the war.

3. The technical means of air raid defense must be perfect to provide protection under any conditions which might develop in the course of a war that may continue for the next five to ten years. Any other solution would be economically irrational.

Where it is not possible to construct the entire factory below the surface, entirely protected against aerial bombs and artillery shells, at least the important life centers of the factory should be designed so as to be entirely protected. Less vulnerable parts of the factory may be provided only partial protection.

4. Protection against fifth-column activities is best assured by a perfect organization of the technical and engineering set-up of the factory and by harmonious labor conditions which guarantees the solidarity between employers and employees. If satisfactory labor relations prevail every employee becomes a most alert

guard against all types of sabotage.

5. Coordination of all efforts is needed to satisfy these requirements. Chemists and engineers are very quick in grasping the problems of air raid protection. Yet all their efforts and constructive genius are frequently paralyzed by lack of coordination.

As soon as it was generally acknowledged in Germany that simultaneous protection against all risks including high explosive and incendiary bombs was indispensable, the first thing that was done was to make all existing underground structures, both artificial and natural, available for storage of raw materials and finished goods. The deep cellars of wine and liquor dealers were requisitioned for the storage of more important goods such as airplanes or parts of aircrafts. The natural subterranean cavities in salt and other mines in various parts of Germany provide safe storage facilities for millions of tons of materials which are even now beyond the reach of enemy bombers.

Tanks for the storage of oil, gasoline and flammable liquids were built below the ground. Detailed regulations for such forms of constructions were developed and made obligatory at least ten years ago for every new construction job.

The towers of armored concrete, several stories in height, accommodating 500 people or more, have been described frequently—yet only a few such buildings have been erected—less than ten altogether in Italy, Switzerland and Germany. The frequent and lengthy descriptions in the literature may give the impression that such structures are in common use.

Some countries have profited from the natural protection that is afforded by the mountains. Structures are built in the side of mountains and need only a reinforced front wall for protection against fire and explosive bombs.

Where large halls are needed for a plant that cannot reasonably be built entirely under ground, frame structures of steel and concrete have been preferred. Special frame constructions have been so designed that even a direct hit of a high-explosive bomb cannot cause the complete collapse of the entire structure. While the material of which the structures is built should be fire-proof, it must be kept in mind that the contents of the building determine the risk which is caused by incendiary bombs. It seems reasonable and economically supportable that the roofs of all structures should at least protect against small incendiary bombs. Supporting structures should be strong enough for later reinforcements of the roofs, in case that in the course of future developments heavier incendiary bombs are used against factories.

In the chemical industry it has been useful in many instances to divide the manufacturing process into small units. Those units which contain part of a process in which flammable solvents are needed have been placed in smaller structures which provide full protection against all raid risks. Other installations which represent smaller values and can more easily be repaired or rebuilt when damaged or destroyed by an air raid accordingly receive less protection by expensive architectural structures.

The protection of powder plants against attack from the air is a problem that has not as yet been totally solved. While the engineers of such plants are thoroughly experienced in the prevention of explosions from within, it is, however, not feasible to fortify them by strong structures. The best means of reducing to a minimum all possible incidents is the isolation of such plants on islands or in locations otherwise separated from inhabited districts. The plants are divided into the smallest possible units which are separated from one another by the greatest possible distances. Plenty of trench shelters reduce the number of casualties. The employees of the plants are subjected to the strictest isolation like prisoners of concentration camps, in order to prevent sabotage acts by the employees themselves or by individuals who might illegally enter the property of powder plants. Additional protection is accomplished by meticulous camouflaging of the plant.

Camouflage of structures has been developed into a special art. Each measure taken must be controlled by observations from the air and continually adapted to changes of the landscape during the seasons of the year and to alterations in the surrounding areas. In some cases mock factories which are built up and frequently broken down again to be rebuilt at different locations nearby, were found extremely useful in confusing enemy bombers so as to divert their attacks from the real target.

The specific technical means of air raid defense include devices for blackout, protection against gases and explosives, fire-fighting, fire-prevention equipment, hygienic and utility requirements such as lighting, ventilation, sanitation, power, gas and water supply. Also of importance are the planning, distribution, designing, equipment and management of air raid shelters, the structural requirements of shelters and factory buildings. All these and many more problems in these fields have been studied by engineers, architects and military experts in Germany and Russia during the last 20 years.

Hundreds of devices have been patented every month by manufacturers and individual inventors and have been tested and approved by the research institutes on air raid defense in Germany, Czechoslovakia, Russia and elsewhere. Architects who built factories used the best devices that could be obtained on the market at the time. Air raid protection equipment has thus become standardized.

Partial solutions of air raid defense problems represent the kind of mistake that is most frequently repeated everywhere. There have been factories with excellent blackout provisions and lighting equipment, but no protection against other risks. Many years ago the correct adjustment of the power supply was imposed on German factories by meticulous regulations. Yet at the same time other air raid precautions in the field of water and gas supplies and telephone service were not perfected.

Everyone has learned the lesson by practical experience that balloon barrages and anti-aircraft guns cannot prevent air raids. There is no other military defense against air raids except preventive counter attack by overwhelmingly superior air forces. Will the American industry learn this lesson from the manifold experiences of the Poles, Germans, Italians, French and British? If Americans do so, they will indeed be the first people in the world that learns from the experience of others.

It is impossible to paint a reasonable picture of what has been done in Europe in a brief article. It would also give a wrong impression if I were to pick out at random one special example that has been constructed in Europe. European factory buildings have made many mistakes at times. Only a few solutions can be considered perfect. Among them are the underground storage facilities in the salt mines in central Germany and the underground airport and factory buildings.

CHEM & MET REPORT ON

Chemical Industries' Role Midwestern Economy

TO CHEMICAL ENGINEERS AND EXECUTIVES EVERYWHERE

National defense has brought into sharper focus the strategic importance of our vast Midwestern Empire. With a quarter of the area of the United States and a third of its population, the fourteen States west of the Alleghenies, east of the Rockies and north of Tennessee account for 41 percent of all manufacturing and 35 percent of the production of the chemical process industries. Within this area Uncle Sam has selected sites for more than two-thirds of his huge munitions plants. Will they some day become the focal centers for still greater development of chemical enterprises? Raw material resources, labor, transportation and power facilities combine with a growing market to encourage a trend in decentralization and diversification of industry and agriculture that chemical engineers can afford to watch with interest.

CHEMICAL AND METALLURGICAL ENGINEERING
APRIL, 1941

Looking to the Future Development of a Greater Midwestern Empire

SUMMARY AND CONCLUSIONS

Forty-two and a quarter millions of people live in that part of our country west of the Alleghenies, east of the Rockies and north of Tennessee. The area of the 14 states of Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, West Virginia and Wisconsin, is 27 percent of the nation's total. In 1939 these States produced 41 percent of all manufactured goods and 34.8 per cent of those classified as products of the chemical process industries. Much of this vast area is predominantly agricultural in character, but there is good reason to believe that the present defense program will point the way toward a better balance between farm and factory—a sounder economy as these great governmental projects become the nuclei of expansion for progressive chemical and process industries.

Evaluating Western Trends

RECENTLY a reporter asked William S. Knudsen, director-general of the Office of Production Management, how we are making out on the national defense program. Pointing directly above to a pin-dotted map of the United States, Mr. Knudsen said, "Every one of those dots is a defense project started or expanded since last July. If you will look closely, you will see that we are gradually shoving the dots in this direction." He was indicating the West and more specifically the Middlewest.

There can be no doubt but that that is the direction in which the national defense program is moving. Why? Is it purely because of military strategy in locating munitions plants in the interior of the country? Perhaps that is one reason but of even more economic and social significance is the evident trend toward decentralization of industry and diversification of our national economy.

Chester C. Davis, agricultural commissioner of the National Defense Advisory Commission, has ably charted these trends in several recent speeches. In an address January 31 before the Illinois Agricultural Association in St. Louis, he said: "I believe this Nation should carry out the principle that no new defense industries should be located in areas where the heavy industries essential to defense are now concentrated when there is any possibility of placing them elsewhere. That is the only way in which new reservoirs of unemployed labor and resources can be tapped without uprooting families and shifting them thousands of miles into communities where ebbing of the armament effort will leave them stranded. The plans that were made prior to the emergency for maximum war production were not based on such a principle. In carrying out the program in recent months we have made some progress toward decentralization, but I am far from satisfied."

More recently, on March 8, in breaking ground for a new bomber plant in Kansas City, Mo., Mr. Davis again touched on these trends: "It would have been possible and perhaps easiest," he said, "to have launched this whole (national defense) program in the established centers of industry, to have built additions to existing plants and to have put new plants next door to old ones. But it was apparent to my colleagues and to me that this was the wrong way. If we followed this procedure, we soon came to realize, we would encounter labor shortages in the industrial areas. It would set in motion a vast migration of people to jobs which could continue only so long as we were producing the munitions of war. We would unnecessarily congest our transport facilities and our schools and public services. And, I may add, we could expect serious protests from those parts of the country which found themselves being drained of their best man-power and equipment."

"I am fully prepared to admit the strength of the forces which lead to industrial concentration. I am prepared to believe that without conscious, intelligent effort, industrial growth will lead to centralized industry. However, I am equally certain that here in the United States we must reject the inevitability of such concentration. The goal of a well distributed industry is essentially the goal of a well diversified economy."

That the plant expansion for new national defense facilities is following this pattern is quite evident from the accompanying charts of the National Industrial Conference Board. Of $2,053,227 appropriated for plant

expansion and new defense facilities from June 13, 1940 to February 28, 1941, $736,140,000 was for "Arms, ammunition and explosives." The largest allotment of this, $259,769,000, went to the East North Central States of Ohio, Indiana, Illinois, Michigan and Wisconsin. Second largest appropriation of $173,198,000 went to the West North Central States of Minnesota, Iowa, Missouri, North Dakota, Nebraska, and Kansas.

Ohio and Pennsylvania are the leading states for all defense plant contracts closely followed by Michigan and Indiana. Of the 14 ranking states where plant contracts have totaled more than $40,000,000 each, seven are in the area west of the Alleghenies, north of Tennessee and east of the Rockies. Furthermore, careful observers in Washington report that in the future thinking and planning for a 4,000,000-man army, a lot of thought is being given to the area west of the Mississippi and east of the Rockies. This is the area in which the next armament plants will probably be built.

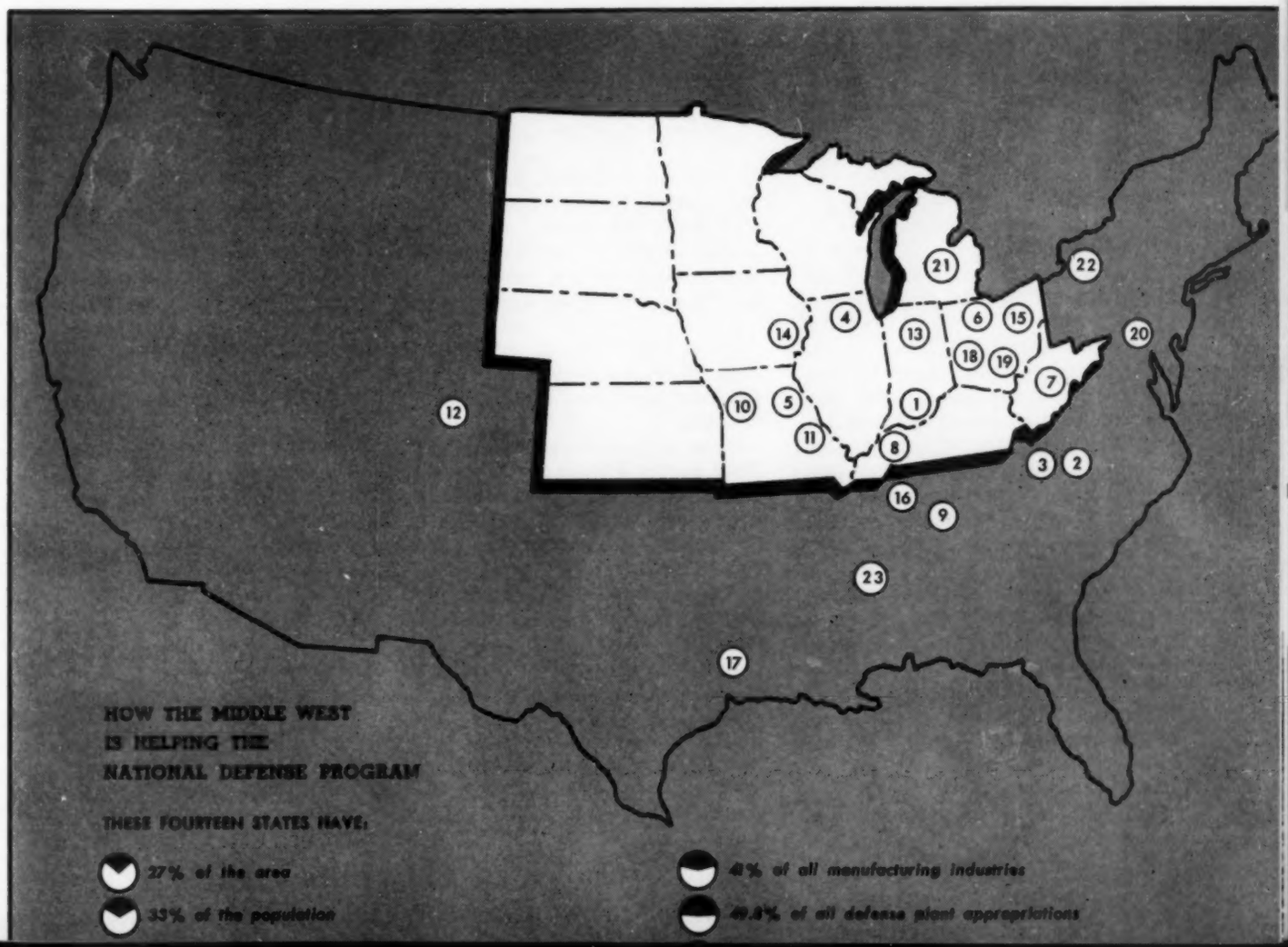
As will be noted from the accompanying tabulation of the National Industrial Conference Board (Economic Record, March 24, 1941) the total expenditures for defense plant capacity at the end of February totaled $2,053 million. In contrast, all of the estimated expenditures for manufacturing plants in 1939 for private industry, totaled $775 million and $1,441 million in 1929. For plant and equipment, $2,425 million was spent in 1939 and $3,596 million in 1929.

Defense plant expansion entered

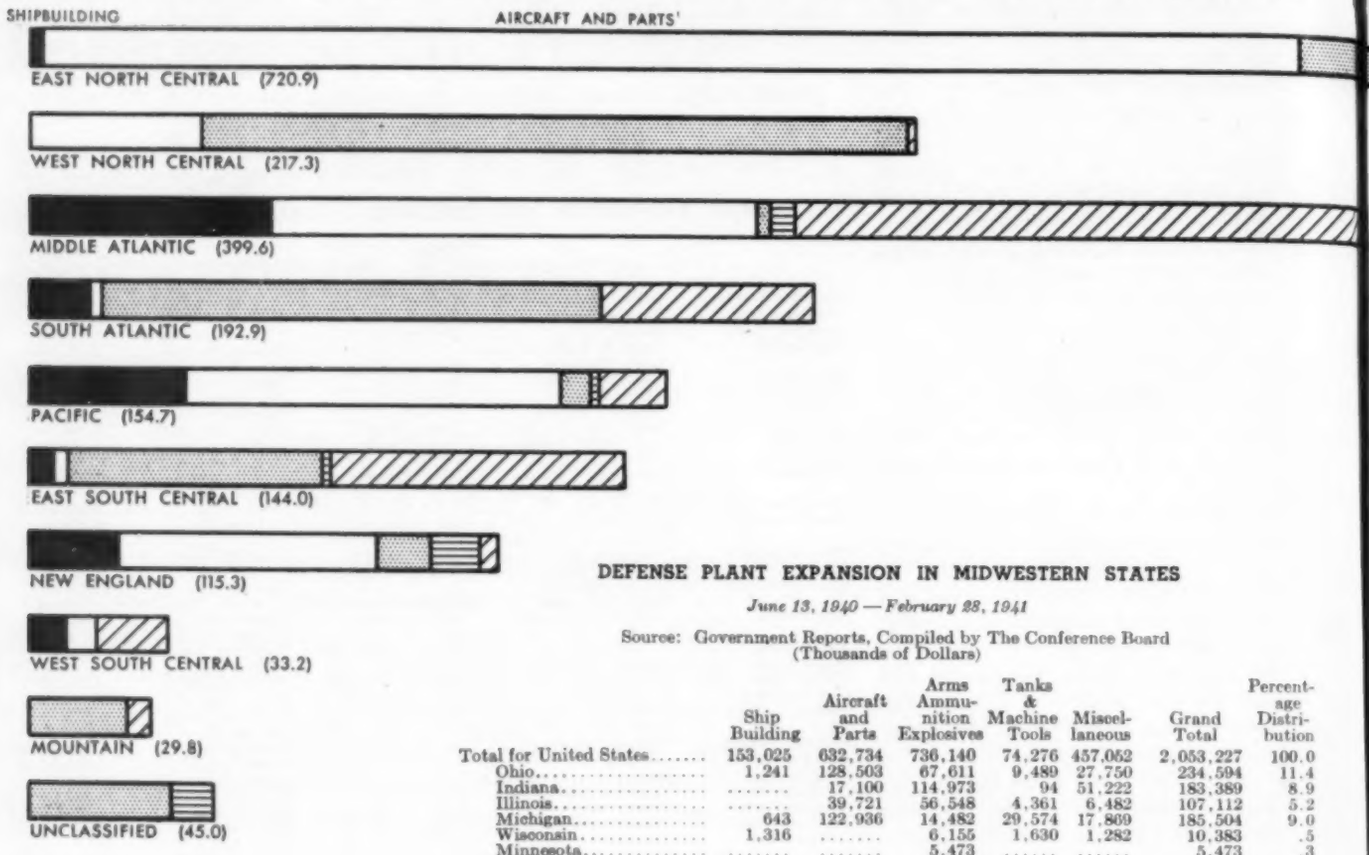
ARMS, AMMUNITION AND EXPLOSIVES PLANTS CONTRACTED FOR

Prior to April 1, 1941

Type	Contractor	Operator	Location	Cost	Map
Smokeless Powder	DuPont	DuPont	Charlestown, Ind	$74,348,000	1
Smokeless Powder	Hercules Powder	Hercules	Radford, Va	26,037,050	2
Smokeless Powder	DuPont	DuPont	Childersburg, Ala	47,302,000	23
Bag Loading	Const: C. F. Haglin Sons.		Charlestown, Ind	15,227,080	1
	Equip.: Goodyear	Goodyear Engrg. Corp.		2,373,446	1
Bag Loading	Mason and Hanger	Hercules	Pulaski, Va	9,487,430	3
Bag Loading	Not Announced	DuPont	Childersburg, Ala		23
TNT-DNT-Tetryl	Stone and Webster	DuPont	Wilmington, Ill	31,211,030	4
TNT-DNT-Tetryl	Fraser-Brace Co., Inc	Atlas Powder	Weldon Springs, Mo	11,324,700	5
TNT-DNT	E. B. Badger & Sons	Trojan Powder	Sandusky, Ohio	9,388,330	6
Ammonia	DuPont	DuPont	Morgantown, W. Va	15,810,409	7
Ammonia	Atmospheric Nitrogen Corp.	Solvay Process Co	West Henderson, Ky.	13,285,000	8
Ammonium Nitrate	T.V.A.	T.V.A.	Muscle Shoals	6,500,000	9
Small Arms Amm	Fruco Construction Co.	U.S. Cartridge	St. Louis, Mo	12,796,800	11
	Equip.: U. S. Cartridge				
Small Arms Amm	Foley Bros., Inc.		Lake City, Mo	7,625,890	10
	Equip.: Remington Arms	Remington Arms		13,500,000	10
Small Arms Amm	Gordon Broderick		Denver, Colo	13,289,490	12
	Equip.: Remington	Remington Arms		14,800,000	12
Shell Loading	Bates & Rogers Const. Corp.	Todd and Brown	Union Center, Ind	12,377,330	13
Shell Loading	A. Guthrie Co., Inc	Day and Zimmerman	Burlington, Iowa	9,932,420	14
Shell Loading	Hunkin-Conkey Const. Co.	Atlas Powder	Ravenna, Ohio	16,726,565	15
Shell Loading	Sanderson and Porter	Sanderson and Porter	Wilmington, Ill	14,454,700	4
Shell Loading	H. K. Ferguson Co	Procter and Gamble	Milan, Tenn	8,991,200	16
Toluol	Humble Oil Refining Co	Humble Oil	Bay Town, Texas	11,857,000	17
	(Includes $1,097,000 to equip existing plant under five-year amortization)				
Activated Carbon	National Carbon Co	National Carbon	Fostoria, Ohio	1,000,000	18
Activated Carbon	Barnebey-Cheney Co	Barnebey-Cheney Co.	Zanesville, Ohio	1,000,000 est.	19
Chemical Warfare	DuPont	DuPont	Niagara Falls, N. Y.	2,168,000	22
Chemical Warfare	Monsanto Chemical Co.	Monsanto	St. Louis, Mo	2,352,100	11
Chemical Warfare	Dow Chemical Co	Dow	Midland, Mich	2,084,370	21
Edgewood Arsena Cantonment	Cummings Const. Corp.	Chemical Warfare Service	Edgewood, Md	7,336,900	20



DEFENSE CONTRACTS FOR EXPANSION OF PLANT AND FACILITIES BY REGIONS — JUNE 13, 1940 TO



DEFENSE PLANT EXPANSION IN MIDWESTERN STATES

June 13, 1940 — February 28, 1941

Source: Government Reports, Compiled by The Conference Board
(Thousands of Dollars)

	Ship Building	Aircraft and Parts	Arms Ammunition Explosives	Tanks & Machine Tools	Miscellaneous	Grand Total	Percentage Distribution
Total for United States	153,025	632,734	736,140	74,276	457,052	2,053,227	100.0
Ohio	1,241	128,503	67,611	9,489	27,750	234,594	11.4
Indiana	.....	17,100	114,973	94	51,222	183,389	8.9
Illinois	.....	39,721	56,548	4,361	6,482	107,112	5.2
Michigan	643	122,936	14,482	29,574	17,869	185,504	9.0
Wisconsin	1,316	.....	6,155	1,630	1,282	10,383	.5
Minnesota	.....	.....	5,473	.....	.....	5,473	.3
Iowa	.....	.....	44,348	.....	28	44,376	2.2
Missouri	.....	13,968	122,876	.....	1,375	138,219	6.7
North Dakota	.....	.....	.....	.....	283	283	(a)
South Dakota	.....	.....	.....	.....	.....	.....	.....
Nebraska	.....	8,078	501	.....	.....	8,579	.4
Kansas	.....	20,402	.....	.....	.....	20,402	1.0
West Virginia	.....	.....	51,998	.....	15,025	67,023	3.3
Kentucky	.....	2,505	.....	23	16,600	19,128	.9
Total for 14 Midwest States	3,200	353,213	484,965	45,171	137,916	1,024,465	49.8

(a) Less than one-tenth of one percent.

under the cumulative total of the N.I.C.B. is of three types: direct awards by the Army and Navy, plant expansion financed by the Reconstruction Finance Corporation and the Defense Plant Corporation; and private plant expansion specifically for defense purposes for which special certificates of necessity have been awarded, granting emergency tax depreciation privileges. Government commitments of the first two types have resulted in the expansion or construction of 302 plants involving a cost of almost $1.5 billion.

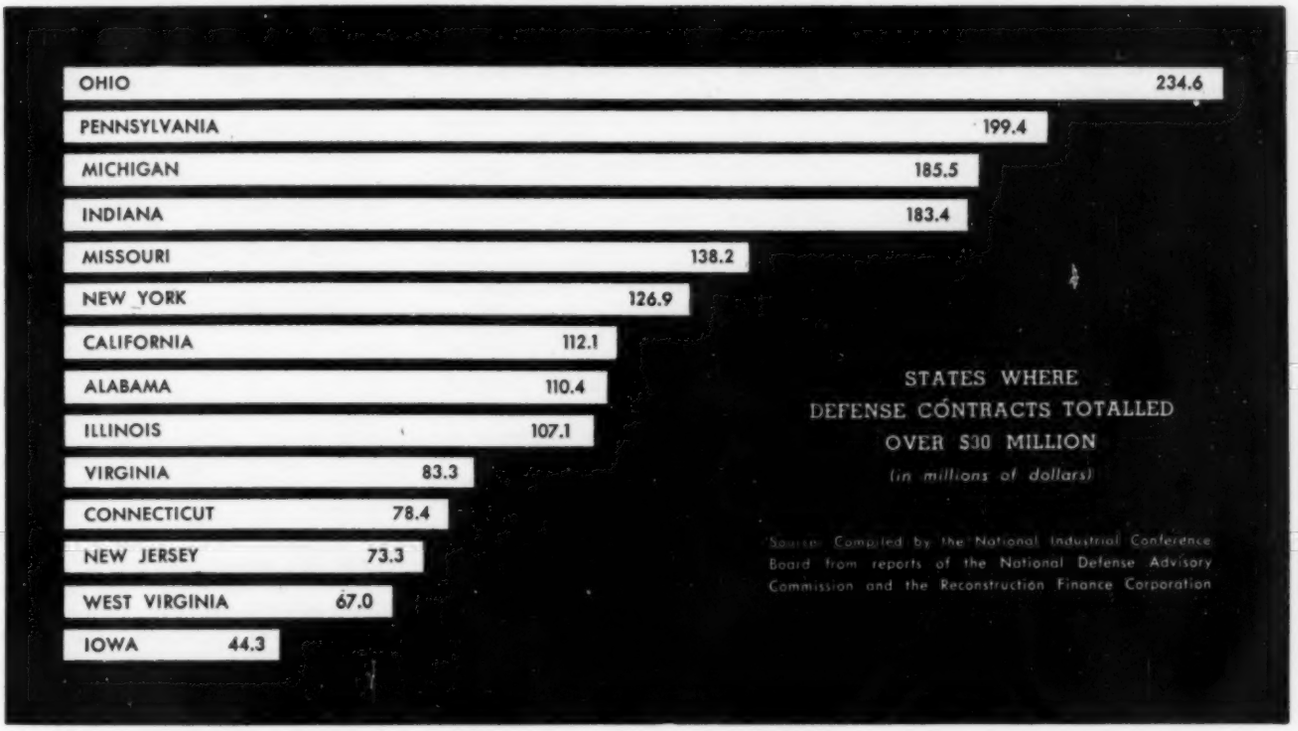
It is significant that these 14 Middlewestern States account for 49.8 percent of the total expenditures for defense plant construction. In the case of "Arms, Ammunition and Explosives," in which chemical industry is most interested, more than 65 percent goes to Middlewestern States.

Going behind these statistics that cover so many widely different items, it is of interest to see how some of these millions are being spent on projects closely related to chemical industry. Major General Charles M. Wesson, Chief of Ordnance of the United States Army, has given us the most recent authoritative review of the explosives program in his speech before the Army Ordnance Association in Chicago, Mar. 17, 1941. He pointed out that from a peace-time production capacity of approximately 100,000 lb. per day of smokeless powder, we are expanding to 900,000 lb. per day at the two plants at Charlestown, Ind. and Radford, Va. and 300,000 lb. at Childersburg, Ala., at a total estimated construction and equipment cost of $145,000,000.

From a peace-time production of TNT in the United States of only about 110,000 lb. per day, we are expanding facilities for making 600,000 lb. of TNT, 100,000 lb. of DNT and 30,000 lb. of tetryl at the plants under construction at Wilmington, Ill. and Weldon Springs, Mo., at a total cost of $47,000,000. An additional 175,000 lb. of TNT and 30,000 lb. of DNT will be made at Sandusky, Ohio.

Six plants for bomb and shell loading, estimated to cost $80,000,000, are being constructed at Savanna, Ill., Ravenna, Ohio, Wilmington, Ill., Union Center, Ind., Burlington, Ia. and Milan, Tenn. Construction has started on two small arms ammunition plants located at Kansas City, Mo., and St. Louis, Mo., estimated to cost $38,000,000. A contract for a third plant at Denver, Colo., to cost $21,000,000, was approved January 4, 1941. Five machine-gun plants at Flint and Saginaw, Mich., Dayton, Ohio, Utica and Syracuse, N. Y., will cost $38,000,000. A plant estimated to cost $20,000,000 for the manufacture of medium weight tanks is being built in Detroit. The two ammonia plants at Morgantown, W. Va. and Henderson, Ky. will produce 570 tons of synthetic ammonia per day. The $10,000,000 toluol plant at Baytown, Tex. will have an initial capacity of 2,000 bbl. per day.

It is not out of place to remark that we once had considerable productive capacity in many of these same fields. If we had held these plants in stand-by condition, rather than scrapping them, our present task would be much lighter. Here is



General Wesson's well-seasoned advice and admonition on this subject:

"My plea to you gentlemen, even at this early stage of things, is to see to it that our production capacity —once we get it—is kept available in stand-by condition. I do not favor government plants for anything more than is absolutely necessary. I hope the day never comes when the factories we are now building for the production of armament are operated by anyone else than the private industry of the United States."

"As this machinery becomes obsolete, it should be replaced with new machinery, and in the process of doing so we should consider such expenditures of public funds as being entirely on a par with the replacement of obsolete equipment in any other field of national defense, whether it be destroyers, battleships, airplanes or guns. Today the factory and its machinery stand on an even plane with the fighting equipment of the soldier on the battlefield."

So it is apparent that those who are planning our defense program are not concerned with any temporary makeshifts but are building for a fair degree of permanence. They have reason to believe that many of these plants now being built will serve long after the present period of rearmament and defense production is over. Even those that do not survive will have built up able forces of skilled workers, trained managers, power and water facilities that should prove attractive to new peace-time industries.

Since those who are looking to the future balance of agriculture and industry see an increasing opportunity for chemical enterprises, it is appropriate to review the present status of this area from a chemical standpoint and to see what other attractions there are for further chemical developments during and after the present emergency.

Midwestern Chemical Industries

With 28.17 percent of all the plants in the chemical process industries and 34.83 percent of their total output, the 14 Middlewestern States already present a broad and diversified coverage of the chemical engineering field. All of the states in this group, except North and South Dakota, reported tabulatable census data in 1937.

At the outset it should be pointed out, however, that these statistics have a very definite limitation because of the inability of the Census Bureau to publish data that might reveal the operations of individual companies or factories in a particular area. It is somewhat like playing "Hamlet without Hamlet" to find that detailed figures for soap manufacturing are omitted from Ohio's state totals, despite the fact that that state is second only to New Jersey in the U. S. totals. Likewise the broad classification "Chemicals, n.e.c." is omitted for Missouri, which since Civil War days has been a leading chemical producer. However, despite these limitations the census figures are the best we have and are of interest and value in indicating the status and wide spread of chemical development in these Middlewestern States.

The number of establishments reported by the Census of Manufactures in 1937, and the value of products for the chemical process industries are given in the accompanying tabulation. Again, however, the

reader is reminded of the evident limitations on the Census Bureau in presenting compilations of this sort.

Ohio takes her leading position largely because of rubber goods valued at more than a third of a billion dollars. A few years ago, the city of Akron alone was reported to consume nearly 40 percent of the crude rubber of the World and produced about 55 percent of all tires and tubes made in the United States. Ohio, as had already been noted, is the second ranking state among those producing soap and allied products. Glass, ceramics, clay products, pottery and porcelain are also leading Ohio industries and together account for more than $120,000,000 of her annual production. Pulp and paper, paint and varnish, and heavy chemicals are also exceedingly important in Ohio's chemical economy. Its 14 by-product coke plants have a total output valued at $48,653,990

Illinois claims greater diversity of chemical production than any other Midwestern State. Petroleum refining is her most important process industry, followed by paint, pigments and varnishes, chemicals, leather and glass. Illinois ranked ninth in mineral production among the states in 1937. Bituminous coal underlies more than half of the area of the state, whose mines produce about 50,000,000 tons per year—ranking third among the states. Rapidly expanding production of petroleum has put Illinois into sixth position in this field in recent years. Another fast-growing industry is the production and refining of soybean oil. Illinois is sometimes referred to as the "Chemurgic State" because of the advances made there in the utilization of agricultural products as raw materials for chemical industry.

Indiana, because of $190,000,000 of petroleum refinery products, climbs into third place, although it does not have the same wide spread of process industries as does its neighbors on either side. In addition to petroleum, it leads the other Middlewestern States in the production of rectified and blended liquors and ranks third for distilled liquors. The byproduct coke ovens at Gary and East Chicago contribute a sizeable proportion of Indiana's production in this field. Soap and glass are also important industries.

Michigan ranks third in number of process plants, but fourth in value of output. There is a wide diversity of industries represented, with pulp and paper in the leading place, followed closely by chemicals, paint and varnish and drugs and medicines. Michigan leads all other states in the production of salt and, of course, has large chemical industries based on its use as raw material. Paint and varnish production ties in closely with Michigan's leading industry—motor vehicles and bodies.

Wisconsin's high rank comes principally from her 27 pulp mills and 46 paper plants that in 1937 produced $128,000,000 worth of products. Leather tanning and paint and varnish, both centering largely in Milwaukee, are two other sizeable process industries. Wisconsin ranks fifth among the states as a zinc producer and fourth in iron ore output.

West Virginia has an unusually high concentration of chemical industries in the Charleston and Huntington areas. Although the smallest state in the group in area, and eleventh of the fourteen in population, its chemical and glass industries are larger and more important than those in most of the other states. West Virginia ranks fifth among the states in the value of its mineral products in 1937. It was the leading producer of bituminous coal and ranks twelfth in crude petroleum production.

Kansas moves into a ranking position largely because of petroleum refining that accounted for more than 90 percent of the value of products in her process industries.

Missouri has a much more diversified chemical production. Unfortunately the Census does not publish data for chemicals n.e.c. in this state, so that it is patently unfair to rank it on the basis of these fragmentary statistics. It is well known, however, that Missouri holds an important place in fine chemicals, drugs and pharmaceuticals. In the St. Louis marketing area, which includes adjoining counties in Illinois, the Census reports 13 chemical plants with output valued at $25,213,717. Missouri has nine plants in "chemicals n.e.c." for which the Census does not report production. In St. Louis alone are more than 120 establishments engaged in chemical and metallurgical operations. Paints and varnishes, and drugs and medicines are ranking industries among the process groups for which statistics are published. Missouri leads in the production of lead, producing 37.2 percent of the U. S. output in 1939. The Tri-State area, centering in Southeastern Missouri, also produced 36.6 percent of zinc mined in the United States in 1939.

Kentucky takes her place in chemical engineering largely because of 52 establishments that in 1937 produced more than $140,000,000 worth of distilled liquors. Paint and varnish, clay products and leather tanning were also important. Kentucky ranks third among the coal producing states and bituminous coal is her most important mineral output.

Iowa's principal industries are largely concerned with agricultural products and hence are not included in the chemical statistics. Portland cement is a sizeable industry and perhaps helps to account for Iowa's 5,100 miles of fine concrete roads. Clay products, drugs and medicines, grease and tallow are produced by many relatively small plants.

Nebraska, too, is not yet an important chemical producer. More than two-thirds of the production reported for process industries come from 15 plants producing drugs and medicines. Production figures are not included in the Census for either of the Dakotas, although six plants are listed for *North Dakota* and eighteen plants for *South Dakota*.

Mines producing less than $100,000 are mostly not recorded. Scattered production is usually added to the largest producer. Coal, oil, construction materials and common clays are not shown. Production for entire states not necessarily shown on proper locality. According to Raisz, *Mining & Metallurgy*, March, 1941

CHEMICAL PROCESS INDUSTRIES OF THE MIDDLE WEST

Number of Plants and Value of Products as reported by U. S. Census for 1937

Illinois

Industries	Number of Establishments	Value of Products
Blacking, stains & dressings	17	$943,457
Cement	5	7,897,271
Chemicals (n.e.c.)	47	61,335,738
Clay products, other than pottery	64	8,275,533
Cleaning & polishing preparations	38	6,967,088
Coke-oven products	6	25,082,672
Compressed & liquefied gases	17	3,670,254
Drugs & medicines	91	27,929,392
Explosives	6	4,240,967
Fertilizers	12	5,449,734
Fireworks & allied products	4	375,226
Glass	9	35,325,035
Glue & gelatine	16	8,532,720
Grease & tallow	14	5,472,710
Ink, printing	33	9,633,244
Insecticides & fungicides	62	11,542,922
Leather, tanned & curried	26	33,914,413
Liquors, distilled	5	23,330,191
Lubricating oils & greases	14	3,527,122
Minerals & earths	9	1,856,090
Mucilage	5	127,330
Oils (n.e.c.)	11	8,906,663
Paints, pigments & varnishes	107	79,945,742
Paper	24	32,031,766
Paving materials	7	3,002,039
Perfumes, cosmetics	57	14,292,694
Petroleum refining	11	115,545,654
Roofing, built-up & roll	19	28,746,196
Rubber goods (other)	23	12,147,684
Pottery, including porcelain	14	3,819,764
Soap	20	24,880,925
Tanning materials, etc.	4	302,736
Wall board & plaster	14	5,127,913
Wood preserving	12	7,645,853
Totals	822	$621,735,778

Indiana

Cement	5	$9,203,376
Chemicals (n.e.c.)	11	17,524,913
Clay products, other than pottery	46	6,620,310
Cleaning & polishing preparations	7	677,276
Coke oven products	4	43,249,409
Drugs & medicines	43	36,022,938
Fertilizers	13	4,509,175
Glass	18	38,558,514
Grease & tallow	14	733,729
Insecticides & fungicides	5	534,113
Leather, tanned, curried & finished	5	3,321,801
Lime	6	720,072
Liquors, distilled	7	18,275,658
Paints, pigments, varnishes	24	12,315,308
Paper	20	14,794,605
Perfumes, cosmetics	8	307,403
Petroleum refining	6	190,332,763
Pottery, including porcelain ware	6	2,847,834
Rubber goods other than tires, etc.	13	7,013,374
Soap	9	42,132,057
Wallboard & insulation	9	3,121,309
Wood preserving	5	5,091,909
Totals	277	$457,907,846

Iowa

Cement	5	$7,930,826
Chemicals (n.e.c.)	4	4,761,738
Clay products other than pottery	27	3,272,288
Cleaning & polishing preparations	6	328,588
Drugs & medicines	26	3,352,894
Grease & tallow	26	1,644,468
Gypsum products	6	3,816,234
Insecticides &f ungicides	4	96,499
Oils (n.e.c.)	5	1,868,470
Paints, pigments & varnishes	5	363,949
Perfumes, cosmetics, etc.	5	3,490,146
Totals	119	$30,926,100

Kansas

Cement	7	$6,162,288
Clay products other than pottery	14	1,408,376
Drugs & medicines	18	617,472
Lubricating oils & greases	10	828,306
Paving materials	3	65,214
Petroleum refining	18	102,490,429
Salt	7	4,141,548
Totals	77	$115,713,723

Kentucky

Chemicals (n.e.c.)	3	$1,332,973
Clay products other than pottery	36	5,912,988
Drugs & medicines	8	484,142
Fertilizers	3	1,661,644
Leather — tanned, curried & finished	3	4,201,158
Liquors distilled	52	40,314,833
Paints, pigments, varnishes	24	12,264,914
Paving materials	3	406,774
Petroleum refining	7	20,954,056
Rubber goods (other)	3	58,210
Totals	142	$87,591,692

Michigan

Cement	11	$10,484,558
Chemicals (n.e.c.)	22	60,035,644
Clay products other than pottery	15	1,943,257
Cleaning & polishing preparations	19	6,591,485
Compressed & liquefied gases	16	2,823,233
Drugs & medicines	35	44,975,552
Fertilizers	5	2,671,260
Grease & tallow	9	2,807,885
Gypsum products	9	3,752,837
Ink, printing	7	2,594,942
Insecticides & fungicides	24	5,073,177
Leather — tanned, curried, etc.	13	21,281,324
Lubricating oils & greases	7	2,397,839
Paints, pigments & varnishes	50	48,224,221
Paper	46	92,418,197
Petroleum, refining	9	21,999,689
Pulp	9	7,054,928
Rubber goods (n.e.c.)	12	8,431,955
Salt	7	9,070,190
Sand lime brick	4	222,990
Soap	4	201,479
Wood distillation	5	3,324,499
Wood preserving	6	2,644,703
Totals	344	$361,028,844

Minnesota

Chemicals (n.e.c.)	5	$1,484,327
Clay products other than pottery	11	975,960
Cleaning & polishing preparations	8	529,490
Coke-oven products	3	7,727,617
Compressed & liquefied gases	11	1,389,412
Drugs & medicines	23	6,700,328
Grease & tallow	7	550,863
Insecticides & fungicides	13	1,143,182
Lubricating oils & greases	9	919,323
Oil cake & meal, linseed	5	14,334,978
Paints, pigments & varnishes	21	4,401,116
Paper	9	19,124,423
Perfumes, cosmetics, etc.	13	576,649
Pulp (wood & other fiber)	7	8,190,736
Roofing, built-up & roll	4	3,253,456
Sand-lime brick	3	150,329
Soap	6	1,075,073
Wood preserving	13	6,016,504
Totals	171	$78,543,766

Missouri

Blacking, stains & dressings	9	$1,254,945
Cement	5	7,379,985
Clay products	41	14,383,035
Cleaning & polishing preparations	21	2,794,658

Missouri (cont.)

Compressed & liquefied gases	13	2,201,576
Drugs & medicines	58	24,335,460
Explosives	3	3,317,007
Grease & tallow	3	110,414
Ink, printing	11	1,330,030
Insecticides & fungicides	23	2,720,047
Leather — tanned, curried & finished	4	1,892,875
Lime	10	2,831,680
Lubricating oils & greases	8	1,612,816
Minerals & earths	4	209,258
Paints, pigments, varnishes	47	27,768,739
Paving materials	8	728,083
Perfumes, cosmetics	29	4,719,843
Roofing, built-up & roll	4	1,376,111
Rubber goods (other)	13	5,300,314
Totals	314	$106,266,876

Nebraska

Clay products other than pottery	8	$474,467
Drugs & medicines	15	2,207,639
Grease & tallow	7	464,742
Insecticides & fungicides	3	61,545
Paints, pigments, varnishes	5	329,829
Perfumes, cosmetics	4	74,102
Totals	42	$3,612,324

North Dakota (See Footnote)

Ohio

Blacking, stains & dressings	5	$103,520
Cement	10	9,090,989
Chemicals (n.e.c.)	49	64,315,497
Clay products other than pottery	172	29,865,536
Cleaning & polishing preparations	33	8,339,478
Coke-oven products	14	48,653,990
Compressed & liquefied gases	35	6,416,273
Drugs & medicines	64	9,640,802
Fertilizers	24	12,978,420
Glass	26	62,050,523
Grease & tallow	29	4,448,528
Ink, printing	14	2,562,212
Insecticides & fungicides	29	2,321,271
Leather — tanned, curried, & finished	14	14,721,297
Lime	15	7,610,463
Lubricating oils & greases	31	5,218,323
Matches	4	12,996,661
Minerals & earths	21	3,324,227
Mucilage, paste, adhesives	6	318,112
Non-clay refractories	6	3,954,703
Paints, pigments, varnishes	97	54,918,984
Paper	48	81,552,239
Paving materials	20	3,906,325
Petroleum refining	13	97,297,783
Pottery, including porcelain	62	25,394,876
Roofing, built-up & roll	8	11,207,725
Rubber goods (other)	72	37,119,777
Rubber tires & inner tubes	17	207,255,214
Salt	5	3,221,157
Wall board & plaster	7	1,328,742
Wood preserving	11	6,205,675
Totals	959	$938,349,322

South Dakota (See Footnote)

West Virginia

Cement	3	$2,519,132
Chemicals (n.e.c.)	12	58,267,326
Clay products	21	3,823,593
Coke-oven products	7	11,101,503
Compressed & liquefied gases	7	1,622,555
Glass	48	52,954,985
Leather — tanned, curried & finished	6	9,683,163
Lime	7	2,367,677
Paints, pigments, varnishes	5	3,049,252

Note: To avoid disclosing data on the operations of individual companies in industries where there are but very few plants within a state, the Census statistics classified by states, do not account for $1,518,222,590 of the $10,624,504,264 of production in the United States. This unclassified production came from 1,494 plants of which 475 were from these Middle Western States, distributed as follows: Illinois, 33; Indiana, 33; Iowa, 25; Kansas, 35; Kentucky, 27; Michigan, 46; Minnesota, 37; Missouri, 61; Nebraska, 18; North Dakota, 6; Ohio, 71; South Dakota, 18; West Virginia, 20; Wisconsin, 45.

West Virginia (cont.)

Industries	Number of Establishments	Value of Products
Paper	5	5,114,949
Petroleum refining	3	11,607,878
Pottery, including porcelain	23	13,554,916
Salt	3	319,394
Totals	150	$175,986,323

Wisconsin

Blacking, stains & dressings	5	$593,923
Clay products	22	569,266
Compressed & liquefied gases	7	985,211
Drugs & medicines	13	1,039,532
Fertilizers	6	1,961,114
Grease & tallow	12	1,194,486
Gypsum	3	140,527
Ink, printing	3	569,768
Insecticides & fungicides	8	406,872
Leather — tanned, curried & finished	17	34,640,267
Lime	10	581,256
Paints, pigments, varnishes	22	12,605,381
Paper	46	97,933,597
Perfumes, cosmetics	3	293,550
Pulp	27	30,292,863
Rubber goods (other)	9	3,407,211
Soap	5	356,793
Fuel briquets	7	3,782,367
Totals	225	$191,353,984

What of the Future?

ON MARCH 26, 1941, a statement of policy on the location of new defense facilities was adopted by the National Defense Advisory Commission. Formal recognition was given to the fact that "on the sites which are selected depends not only the strategic security of our defense industries and much of their efficiency for defense production, but also important and permanent consequences for the economic life of different parts of the nation."

Hereafter, a new plant site committee, headed by Donald M. Nelson, director of purchases for O.P.M., is to review and approve all proposals for new defense facilities. The other members of his committee are Clifford Townsend, special adviser on agricultural and labor matters, Eli Oliver, special assistant on labor relations, E. F. Johnson, Aireraft, Ordnance and Tools Branch of the Production Division of O.P.M., and S. R. Fuller of the Production Planning Board. The committee is to be provided with a technical staff capable of giving detailed studies to proposed locations.

The official announcement stated that "the committee will, insofar as feasible, facilitate geographic decentralization of defense industries and full employment of all available labor." In other words, it is evident that the government intends to use this program wherever it can to contribute to a better balance between industry and agriculture.

This is especially important to the chemical industries of the Middle-West. They are well adapted to that type of economy. They are large users of agricultural raw materials to produce goods like oils and soaps, paint, and paper products that are largely consumed locally. As new purchasing power develops in these communities through more profitable employment, the industries may be expected to grow and prosper.

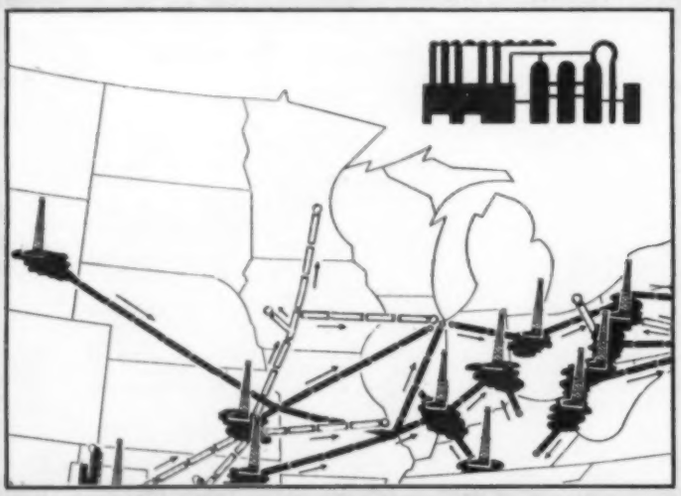
Fortunately the Middle West is amply supplied with practically all of the raw materials for chemical industry. Coal, oil and gas are of basic importance for both fuel and process. Non-metallic minerals such as salt, limestone, barytes and fluorspar, and metallics like lead and zinc are abundantly available. The cereal crops, meat and dairy products and their wastes and byproducts are being subjected to more and more chemical processing.

The defense program is demonstrating that there are large reserves of available labor that can be developed in the non-industralized sections of the Middle West. Efficient transportations by rail, highway and waterway has long been an important factor in this regional development. These 14 states have more miles of railroads than any other section of the United States. It is no accident that many of the largest cities in the territory—Chicago, Detroit, St. Louis, Cleveland and Milwaukee are located on navigable waterways. The Great Lakes provide a vital transportation system for the Middle West of a tremendous magnitude. In 1938, water-borne traffic traversing the Lakes amounted to 108,000,000 tons —almost one-fourth of all the water-borne commerce of the United States. The Mississippi, Ohio and Missouri Rivers add appreciably to the transportation facilities of what was once called the "landlocked civilization of the Middle West."

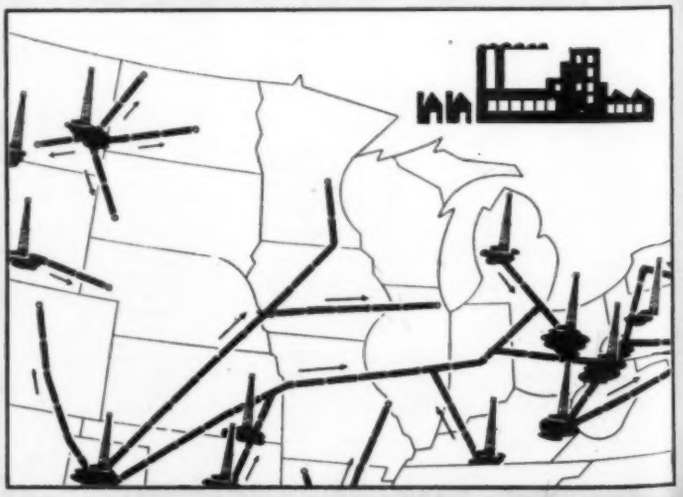
With almost all the necessary raw materials available in abundance, with adequate skilled and unskilled labor, with comparatively cheap fuel for power and process use, with an efficient network of railways and highways and with a steadily growing market as industrialization is bringing greater purchasing power, the chemical industries of the Middle West are in for some important developments within the next few years. Decentralization and diversification of industry are chemical keys to unlock a greater future for Midwestern economy.

Reprints of this 8-page report are available at 25 cents per copy. Address the Editorial Department, *Chem. & Met.* 330 W. 42nd St., New York, N. Y.

From "Petroleum Facts & Figures," 1939



DIRECTIONAL FLOW



DIRECTIONAL FLOW

Making Smokeless Powder at Radford, Va.

THE RADFORD ORDNANCE WORKS, first of the United States Government's defense plants to come into production, began operations March 17 when one of the three powder lines turned out its first smokeless powder.

The contract for the construction of this $40,000,000 plant was signed by the U. S. War Department and Hercules Powder Co., August 16. Ground was broken Oct. 19, 1940. The contract provides that the company construct the plant for a fixed fee to cover design, planning, purchasing and supervision. The company will get a fixed fee per pound of powder turned out. Thus, Hercules is compensated for the technical skill and engineering, and other services it brings to the work. If the cost of the plant or product increases above the estimated figure, the company will not obtain a larger fee for its services.

The plant covering 4,400 acres located four miles from Radford, Va., in Montgomery County on the New River, will have three powder lines, each with a capacity of 100,000 lb. of powder daily.

In connection with the Radford Ordnance Works, the New River Ordnance Works will be constructed near Pulaski, Va., approximately ten miles from Radford. This plant will load some of the smokeless powder produced at Radford into silk bags for use in large caliber guns. Cost of this plant will be approximately $10,000,000. Construction has been started by the Mason & Hangar Co. who have the construction contract from the Government, Hercules acting as architect-engineer for the construction. Hercules will equip and operate the plant on a fixed fee basis.

At the time of the opening there were approximately 22,000 men employed at the Radford plant, construction being carried on during the three eight-hour shifts, seven days a week.

The Radford Works is one of the three smokeless powder plants authorized by the United States Government, the others being the Indiana Ordnance Works at Charlestown, Ind., being built and to be operated by E. I. du Pont de Nemours & Co., and the Childersburg, Ala., Ordnance Works also to be built and operated by du Pont.

Col. Mark M. Serrem of the Army Ordnance Department is in charge of the Radford works. H. V. Chase is manager of the plant for Hercules.

The nitration of purified cotton, the first step at the Radford plant, is accomplished by adding mixed sulphuric and nitric acids to cotton linters. After nitration the nitrocellulose is pumped to a centrifugal wringer revolving at a speed of 1,100 r.p.m. where as much of the excess acid as possible is extracted. It is then "drowned" in cold water and moved to the boiling tubs.

The nitrocellulose is next boiled in acidulated water to break down the unwanted chemical compounds which have formed in the process. After this it is transferred to beating or cutting machines where it is ground under water. This finely ground or pulped nitrocellulose is boiled in alkaline and fresh water and then given cold water washings to remove all impurities.

At this point the nitrocellulose enters the actual "powder line." In the dehydration house a charge of wet nitrocellulose is dumped into a hydraulic press and compressed into a block. Alcohol is pumped through the block in the press forcing out the water. Much higher pressure is then applied which presses out most of the alcohol.

The dehydrated nitrocellulose is sent to a block breaker, which breaks the block into small pieces. This material then goes to the mixing machine in the mix house where ether and alcohol and certain stabilizing chemicals are added, and the ingredients mixed until a mealy mass is formed; and this is more thoroughly mixed in the macerators. The mixed powder is then dumped into a preliminary block-forming press and under pressure formed into blocks 12 in. in diameter and 24 in. long. The blocks are placed in a "macaroni" press, where the powder is forced through a fine mesh screen. The material is then reblocked in a press similar to the preliminary block-forming press.

One or two blocks are put into the finishing press, subjected to a pressure of several thousand pounds per square inch, pressed through dies and forced out in long spaghetti-like strings into fiber buckets. These strings have either one or seven longitudinal holes formed by the dies. The strings are fed into cutting machines, which cut them into grains of the desired lengths. The diameter and length of the grains are varied according to the ballistic characteristics required.

The powder grains are then conveyed to the solvent recovery building where they are treated for several days and most of the ether and alcohol recovered. As the powder still contains too much solvents for use, it is taken to the "water dry" where it is placed in hot water. When the solvent content has been reduced sufficiently, the powder is placed in the air dry house where warm air blown over and through the powder dries it further.

Cannon powders require no glazing, but rifle powders are glazed with graphite to make them flow freely. Rifle is then sieved and cannon powder sorted to remove imperfect grains. The various batches are blended to obtain powder of uniform ballistics and finally packed ready for storage or shipment to loading plants.

Smokeless powder plant at Radford, Va., commences operations

Official U. S. War Department photograph

Machinery, Materials and Products

Chem & Met Process Equipment NEWS

Down-Blast Unit Heater

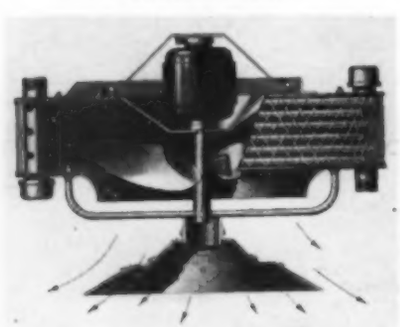
SUPPLEMENTING this company's standard line of floor type and suspended unit heaters, the B. F. Sturtevant Co., Hyde Park, Boston, Mass., has introduced a new down-blast heater said to be more efficient for certain types of installations. Among such are those where unusually high installation is desired. The largest type is said to provide effective heating even when suspended 40 ft. above the floor level. However, for comparatively low installation, deflection cones are employed, resulting in wider diffusion of the heated air stream, and temperature reduction at the working level. Advantages for the new type are said to include better heat distribution, more uniform temperature in the breathing zone, and fuel savings owing to projection of the heat away from exposed ceilings. The new heater consists of a circular, extended-surface heating element, protected by a screen guard, with room air drawn in through the coil and projected downward by a three-bladed fan. Twelve sizes range from 40,000 to 400,000 B.t.u. per hr.

Plastics Mixer

SEVERAL ADVANTAGES are claimed for a new double-rotor, positive-pressure mixer for plastics, rubber compounding and other heavy mixing operations which has recently been introduced by Lancaster Processes, Inc., 620 Fifth Ave., New York, N. Y. As appears from the accompanying cross section, the horizontal rotors are arranged in a vertical plane, rather than in the usual horizontal fashion. The effect of this construction, according to the manufacturer, is to remove the region of bite from the feed chamber and the upper ram, thus eliminating high peak loads and insuring better mixing by eliminating the tendency for unmixed material to stick to the ram. The arrangement is said to provide greatly increased side-wall surface, available for cooling, facilitating effective temperature control. Water, gases, coloring media, etc., may be injected at the bite, to provide for rapid diffusion. Construction of the discharge gate is such that the batch size may be increased above the volume of the working chamber at the outset of the mixing operations, thus compensating for shrinkage accompanying plasticization.

As shown in the accompanying cross section, the feed ram is water-cooled, as are the rotors which run at a slight speed differential. The working chamber body is provided with fins for spray cooling. Both the feed ram and the discharge gate are hydraulically operated.

Down-blast heater



Motor-Operated Valve

PARTICULARLY for use in the automatic control of corrosive liquids, or those containing solids, or viscous or volatile materials, is the new motor-operated Hills-McCanna Saunders' Patent valve recently announced by Barber-Colman Co., Rockford, Ill. The assembly comprises a heavy duty motor-operator which may be controlled directly from a liquid level float, pressure switch, relay, thermostat, pH controller, pushbutton, or other device. Auxiliary switches are available for operating other equipment, such as indicating lights, relays, starters, etc. The valve is of the well-known Saunders type in which closure is effected by depressing a resilient diaphragm against a dam-like element. The valve contains no packing and the body may be had in various alloys, or in cast iron lined with lead, rubber or glass.

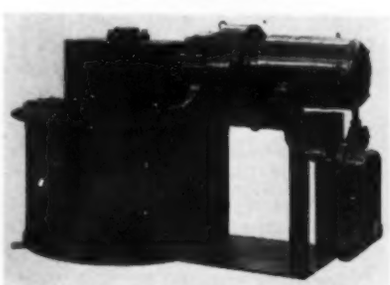
Paste Mixer

EXPANDING its line of chemical processing equipment, the H. K. Porter Co., 4914 Harrison St., Pittsburgh, Pa., has added a series of paint and paste mixers available in capacities ranging from small laboratory sizes to large production models. Designed for any type of motor drive, the new mixers are built in both plain and alloyed steels. The accompanying illustration shows an 80-gal. paint mixer featuring rigid, compact construction, with totally inclosed gears, water-tight discharge gate, explosion-proof motor and controls. A finger type stirrer driven by the vertical shaft runs close to the sides and bottom of the mixer.

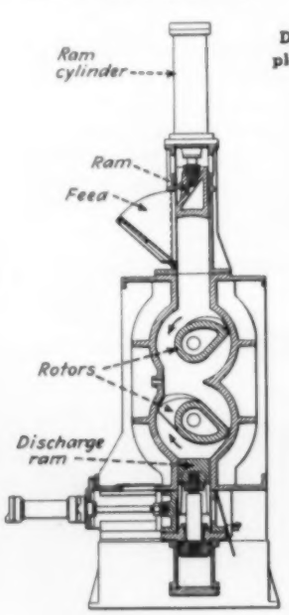
Air-Motor Mixer

FOR USE in mixing batches in the range from 50 to 100 gal., Eastern Engineering Co., 45 Fox St., New

New paint mixer



Double-rotor plastics mixer



Motor-operated Saunders valve

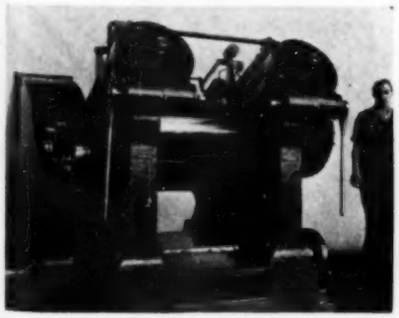
Air-motored portable mixer

Haven, Conn., has announced its new Model A-1 air mixer which is powered by an air-operated motor so that it may be used in any location, regardless of possible fire hazards. The special air motor is said to permit a wide adjustment in speed. Being completely inclosed, it is unaffected by splashing of material or by water or fumes. The motor, which is of ball bearing construction, is rated at ¼ hp., at maximum speed of 2,000 r.p.m. on 100 lb. air pressure. An exhaust silencer, an adjustable clamp, a stainless steel shaft and a 4-in. nickel-plated bronze propeller are standard equipment.

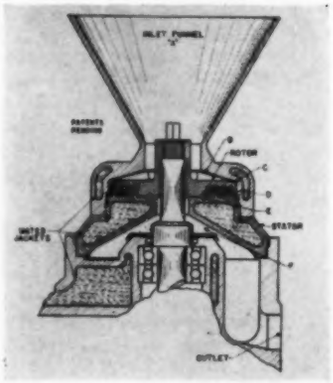
Tilted Refiner

OF INTEREST to rubber reclaimers is the new type tilted refiner recently announced by Farrel-Birmingham Co., Ansonia, Conn. The new machine is said to increase production and improve quality in rubber reclaiming by sharply increasing the maximum roll speed and lowering the stock temperature simultaneously. As compared with the orthodox horizontal machine, the outstanding feature of the new refiner is the fact that its two rolls are so arranged that the center of the hot, or slow, roll is above that of the cold, or fast, roll, which is also the feed roll. Thus, with the affinity of the stock for the cold or lower roll, the stock cannot be forced over the top of the hot, slow roll, but instead is returned by gravity to the top of the feed roll. This arrangement is said to assure cooler stock and a better feed.

Tilted refiner for rubber reclaiming



Three-stage colloid mill



Mixing Truck

FOR USE by chemical and paint manufacturers, the All Steel Welded Truck Corp., Rockford, Ill., has announced a new mixing truck designated as No. 313. This comprises a welded steel platform, supported on rubber-tired casters, on which is mounted a 51-gal. tank, containing a hand-crank-operated propeller agitator. The overall height of the equipment is 39 in. and the size of the pouring spout, 3 in. The truck weighs approximately 330 lb. A feature is the double-hinged cover with hook and eye arrangement for fastening both halves of the cover when it is opened.

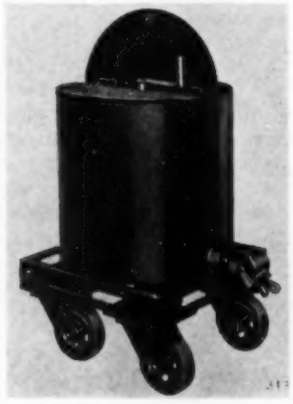
New Colloid Mill

TRIPLE PROCESSING ACTION, with a three-stage rotor, is the feature stressed in a new colloid mill introduced by C. O. Bartlett & Snow, Co., Cleveland, Ohio. High rotor speed, easy feed and discharge of the material, easy disassembly for cleaning and the absence of packing are important features claimed for the new machine. Exceptionally low power consumption per gallon of product is also reported by the manufacturer.

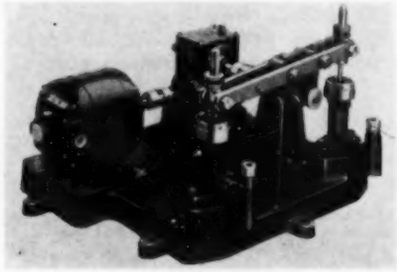
The machine, as shown in the accompanying cross-sectional view, is of the vertical type, with material fed downward from a funnel *A* into the vanes of an impeller *B*, attached to the top of the rotor. The rotor, travelling at 10,800 r.p.m., forces the material across its surface between the vanes, and through the gap at *C*, between rotor and housing, where the first shearing action takes place. The material then passes through the series of labyrinth rings at *D*, where the second stage of processing takes place, then through the third stage in the gap at *E*. Discharge takes place from the annular chamber at *F*. The labyrinth is generally formed of plain rings machined on the bottom of the rotor and top of the stator, but these rings may be slotted or otherwise treated, if desired.

Rotor, stator and inlet chambers are of bronze and the funnel of stainless steel. Semi-steel is used for the housing. Special metals and alloys can be employed if desired. Jackets are provided, as shown, for heating or cooling. Four rotor sizes of 4, 6, 9 and 12 in. diameter are available.

Chemical mixing truck



Type R proportioning pump



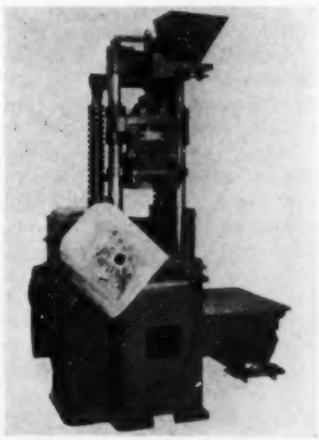
Proportioning Pump

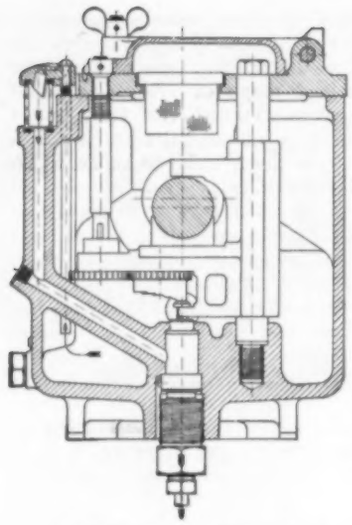
ADDITION of the new Type R proportioning pump to its line has increased the number of different types manufactured by the Hills-McCanna Co., 2349 Nelson St., Chicago, Ill., to nine different varieties made in more than 200 sizes. The new pump has been designed for small capacity, from a few drops per stroke to as high as 8 g.p.h. at working pressures as high as 1,200 lb. per sq.in. The pump employs two cylinders, driven by a balanced walking-beam type rocker arm, with hardened steel roller contact points and oilless bushings. Extra deep end-packed stuffing boxes and outside, vertical, composite-type check valves, of either single or double suction and discharge construction, are employed. The pump is of the constant-speed, variable-stroke type, delivery capacity being adjusted by adjustable plunger buttons.

Vertical Injection Molder

A NEW vertical 2-oz. injection molding machine, which features all instruments and controls mounted in one instrument case, has been announced by the DeMattia Machine & Tool Co., Clifton, N. J. This machine is fully mechanical and is said to be extremely

Vertical injection molder





High-pressure lubricator

New Radiamatic pyrometer

simple in operation. Pressing a button puts the machine in operation through an automatic time sequence. The cycle may be varied between 140 and 500 injections per hour. Power supplied by a 10 hp. motor is transmitted through a cam-actuated toggle, closing the mold under 100 tons pressure. Injection is accomplished by a preloaded spring injection moment beam, actuated from a crank. Full follow-up pressure is maintained through the dwell period by means of the preloaded beam.

High Pressure Lubricator

OPERATION against pressures up to 20,000 lb. is possible with a new mechanical lubricator known as Type HD which has been announced by the Nathan Manufacturing Co., 250 Park Ave., New York, N. Y. The lubricator has four independent pumping units, one for each feed outlet, which are located inside the oil reservoir, each consisting of a packless piston fitted oil-tightly into a cylinder. Each draws oil from the reservoir through a sight-feed glass. Each pumping unit is actuated by a yoke which in turn is driven by an eccentric shaft. Regulation of each feed can be accomplished independently by adjusting the effective stroke of the piston. Either ratchet drive or a rotary drive for motor connection can be employed.

New double-cone blender

New Regor coupling

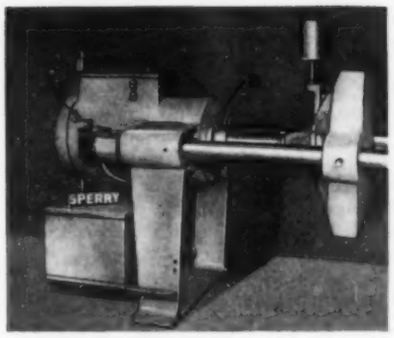
Radiation Pyrometer

A SELF-CONTAINED radiation pyrometer which is compensated for ambient temperatures errors has been introduced by the Brown Instrument Co., Philadelphia, Pa. Known as the Radiamatic, the new pyrometer is said to operate successfully under severe conditions of temperature and vibration. It consists essentially of a heat-resisting lens, a compensator and a thermopile. Heat from the hot object focused on the thermopile generates an emf. proportional to the object temperature, which operates an indicating, recording or controlling potentiometer. Special features include construction said to be unaffected by dust, dirt, fumes and corrosive atmospheres, coupled with ease of installation and freedom from ambient temperature variation errors.

Press Closer

MORE THAN two years of field testing in several large plants is claimed for a new electro-hydraulic filter-press closing device, recently announced by D. R. Sperry & Co., Batavia, Ill. According to the manufacturer, no repairs or service were required during the test period. The device is oil-powered, under simple electrical control, thus eliminating the usual hydraulic valves. It can be applied to most existing filter presses.

In operation the Type EHC closer is used as follows: to open, control



Electro-hydraulic press closer

handle *A* is moved forward and locknut *B* is unloosened two turns. The filler block is then swung upward and the movable head pulled back into the open position. In closing, the head is pushed forward to contact plates and frames, the filler block dropped into place, the control handle moved forward to squeeze the press to the desired pressure, as shown on the gage, and the locknut then spun into tight position.

Double Cone Blender

FOR MIXING of such dry materials as pharmaceuticals, dry colors, chemicals, graphite, plastics and many other substances, the H. K. Porter Co., Process Equipment Division, Pittsburgh, Pa., has introduced a new double-cone blender made in a wide range of sizes, from laboratory to large production models. Features of the new blender include all-welded construction, inclosed cut-tooth gears, self-aligning, anti-friction bearings and fully inclosed dust-proof construction, available in a variety of plain and corrosion-resisting metals. Other features to facilitate operation include an inching drive and easy opening and sealing for expediting charging and emptying. It is claimed that batches in which the uniformity does not vary more than 1 percent can be produced in less than 15 minutes.

Pipe Coupling

COUPLINGS are available for pipe sizes in the range from ¾ to 4 in. in a new design recently offered by Regor Products Co., 333 Kearny St., San Francisco, Calif. The new couplings are of the type consisting of an internal sleeve surrounding the two pipe ends, against which at either end suitable gaskets are forced by means of a pair of body castings drawn together by bolts. Customarily, the body castings are of malleable iron, either with or without galvanizing or plating. The sleeves which, together with the gaskets, are the only parts coming in contact with the liquid, are available in malleable iron with various corrosion resisting inner surfaces. Gaskets of rubber, asbestos, lead and other materials are available.

FACTS YOU NEED TO KNOW ABOUT . . .

Cast-Lead Type Evaporators

For the concentration of acids and other corrosive liquors

The cast-lead evaporator, first introduced by Swenson 15 years ago, has made a remarkable record for economy and durability.

In the cast-lead evaporator, as in other horizontal types, boiling liquor surrounds the heating tubes and steam is inside the tubes. The evaporator body is constructed of thick sections of cast lead, with heating tubes of "Karbate" impervious graphite. When temperature and concentration conditions permit, a number of its parts, particularly the vapor piping and condenser, can be built of rubber-lined steel.

ADVANTAGES

The cast-lead evaporator has proved extremely satisfactory in resisting acid attack and will last indefinitely. It is far superior to lead-lined evaporators.

Like other horizontal-tube units, the cast-lead type evaporator is extremely simple in design. Heating tubes can be renewed and repairs can be made without trouble. Its sectional construction makes possible localized, and hence low cost, repairs. It is easy to operate continuously and has the ability to carry a large volume of liquor in the body when finishing to a definite density under batch operation. It requires relatively little headroom when installed and small cargo space when boxed for export.

TYPICAL APPLICATIONS

Cast-lead type evaporators have proved to be the solution to many difficult corrosion problems in the rayon, cellophane, pigment, fertilizer, food, and metal refining industries. They are used for the concentration of acids and corrosive organic liquors of many types.

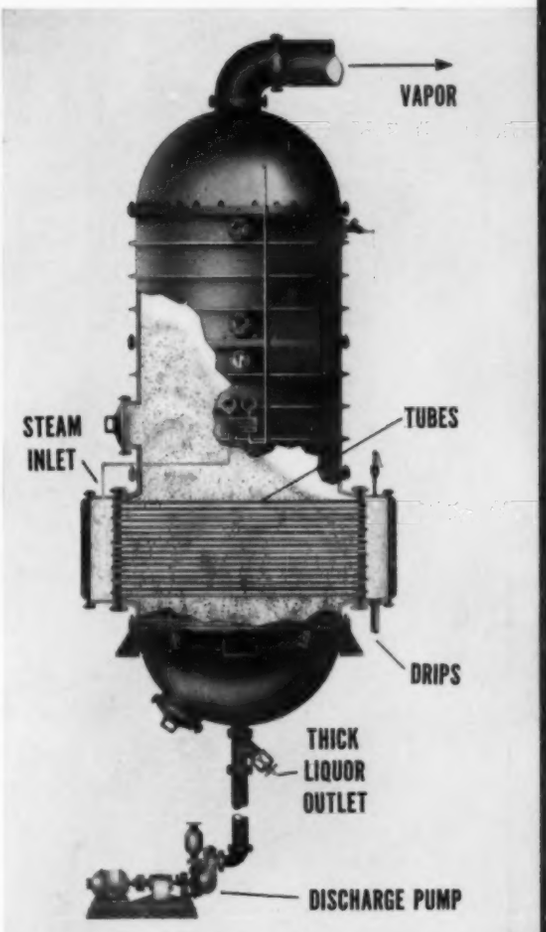
Among the materials that are being concentrated with cast-lead evaporators are crude phosphoric acid, rayon spin bath, acid zinc sulphate, titanium liquor, sulphuric acid, citric acid, tartaric acid, copper electrolyte, and copper sulphate acid solutions.

SPECIAL APPLICATIONS

The cast-lead type evaporator is usually installed as a single-effect unit because of the difficulties of providing packing and seals which are corrosion resistant on both sides of the heating surface. However, Swenson has recently developed a long-tube vertical evaporator equipped with lead tube sheets, lead piping and valves, Karbate tubes, and a rubber-lined steel body and heating element.

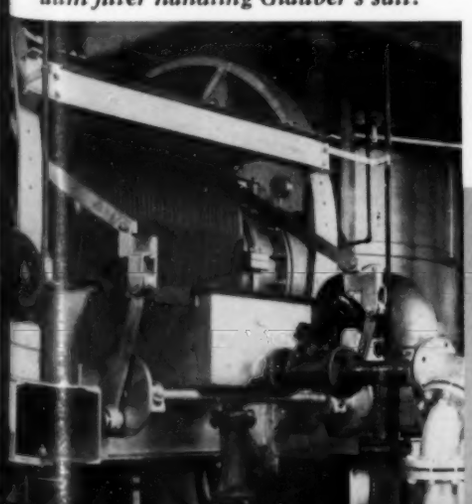
The new rubber-lined L.T.V. unit can be arranged for double-effect evaporation in combination with a cast-lead evaporator—the cast-lead evaporator forming the first effect and the L.T.V. forming the second effect. This combination is operated with a backward feed. Two of the new rubber-lined steel, long-tube vertical evaporators can also be combined into a double-effect unit.

SWENSON offers evaporators for every purpose, including the long-tube vertical type, forced-circulation type, vertical-tube basket type, and horizontal-tube type. Write for bulletin E-135, "Heat Transfer and Crystallization."



PRINCIPLE OF OPERATION

Corrosive liquor enters at the side of the evaporator and surrounds the tubes which carry the heating steam. Vapors rise to the vapor head and pass out to the condenser. Concentrated liquor is discharged by a centrifugal pump.



Cast-lead, rotary-drum type vacuum filter handling Glauber's salt.

SWENSON EVAPORATOR COMPANY

Division of Whiting Corporation • *15669 Lathrop Ave., Harvey, Ill.*

SWENSON

EVAPORATORS

AND FILTERS FOR ACID HANDLING

Chemical Cotton Production

COTTON LINTERS are one of the important raw materials consumed in the production of cellulose base products by the process industries, and, like many other raw materials, they must be purified before being used. The refining operations are performed for the consumer by specialists. The Virginia Cellulose Department of the Hercules Powder Co., has a large purification plant at Hopewell, Va.

The brownish linters must be carefully selected at their source, the cotton seed oil mills, by agents, who are acquainted with their history and also the ultimate use which will be made of them. For example, the smokeless powder manufacturer and the acetate rayon producer are interested in different characteristics of the chemical cotton. As the season for the operation of the oil mill is only five to six months long, it is necessary to anticipate the demand for purified linters for the entire year, which is extremely difficult.

The process of purification consists of both mechanical and chemical means.

Bales of linters are knocked apart, cleaned and fluffed up in a "devil duster." The brownish cotton is then treated with caustic soda at elevated temperature and pressure in a digester in order to put the hulls, oils and waxes in soluble form. The mass is then washed in steel tanks. The bleaching operation is carried out in multiple stages in which the pH is closely controlled. The bleaching is modified to meet the specifications required for the finished linters. After washing, the clean white cellulose flows into a storage tank and from there to the drying or sheeting departments, depending upon their ultimate use.

Linters destined to be converted into viscose rayon are pumped to the sheeting department. Here they are blended, "brushed" in beaters, further refined in jordans, and made into sheets on a fourdrinier paper machine. While the linters to be shipped loose for acetylation or nitration are dried in a tunnel dryer, baled and wrapped for shipment.

Many of the essential steps in the process are illustrated by the accompanying photographs taken in the Hercules Powder Co.'s plant.

CHEMICAL & METALLURGICAL ENGINEERING

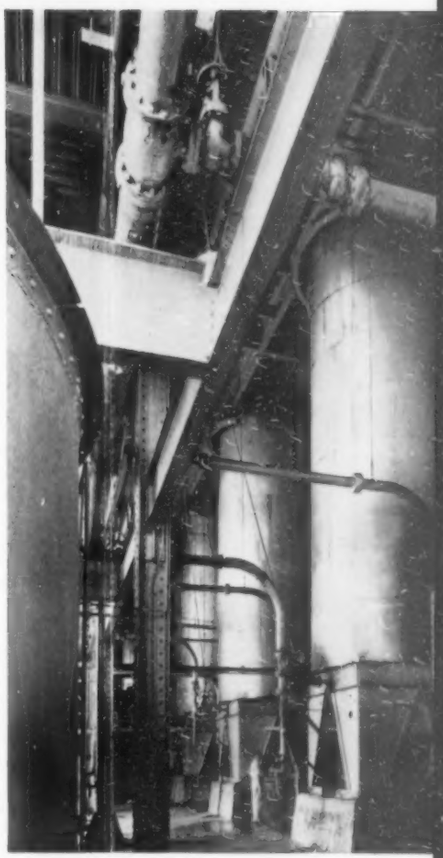
April, 1941

PAGES 108-4 to 111-4

1 One of the digester buildings (tall building at right) of cotton linters purification plant of the Hercules Powder Co. at Hopewell, Va. The cyclone separators can be seen on the roof of the building. Photographs (except one of hollander) by Rittase.

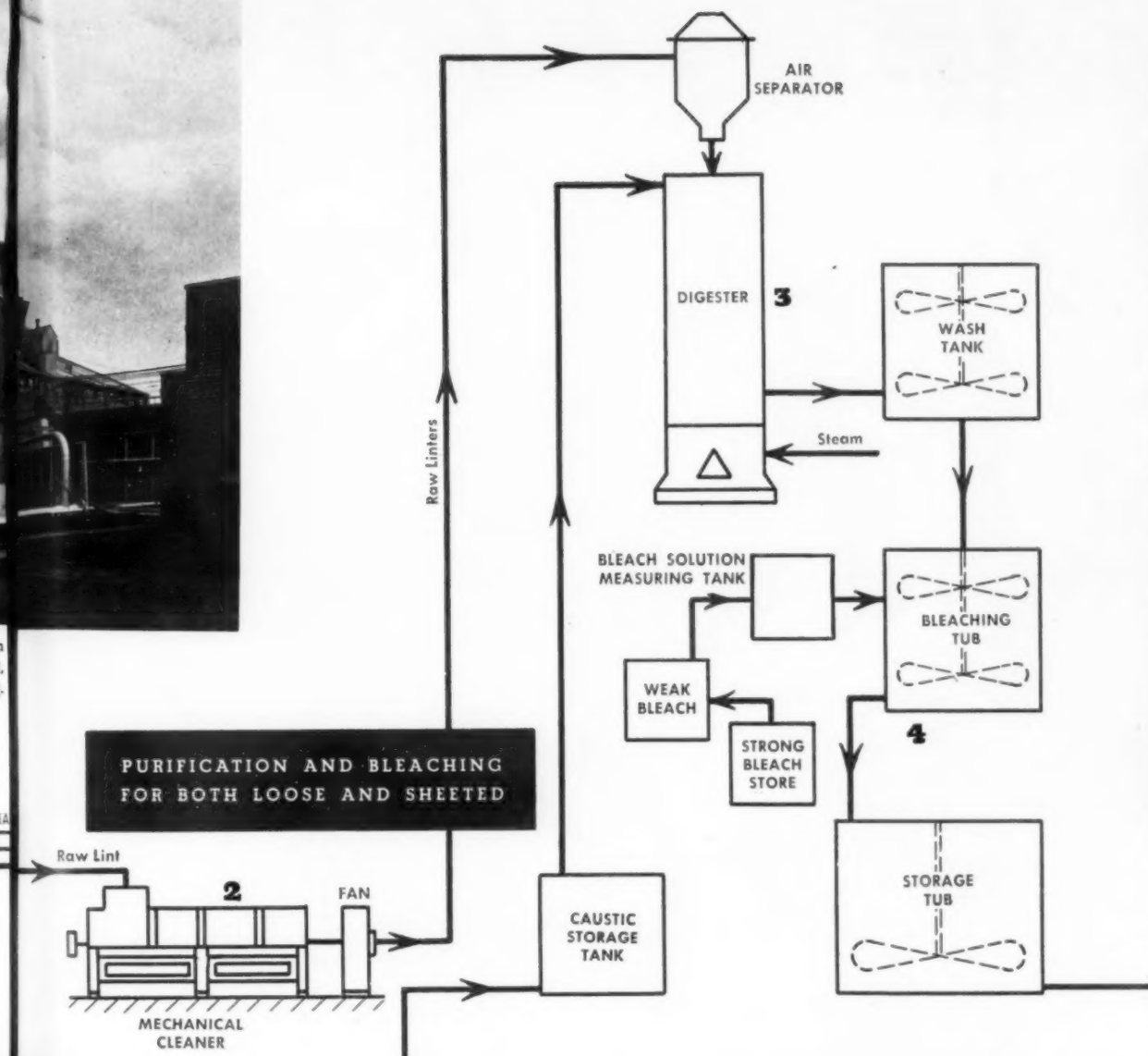
A *Chem & Met* FLOW SHEET

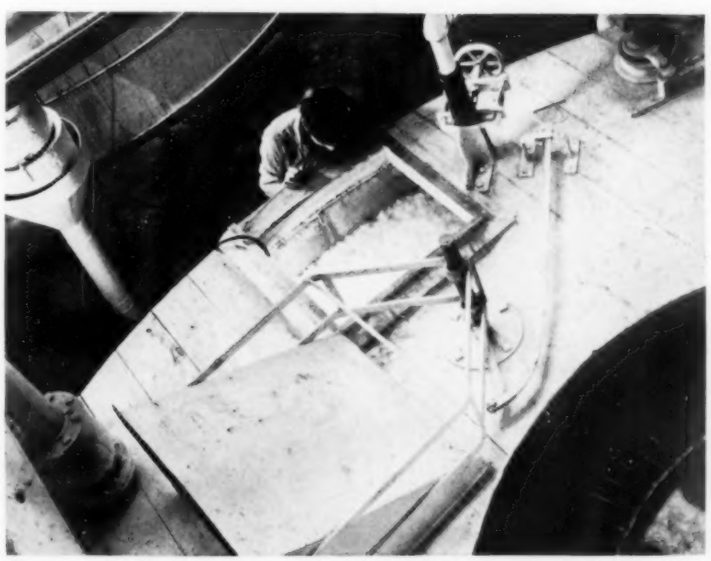
2 Bales of cotton required for a batch are conveyed to a breaker, a rotating cylinder with bronze spikes known as a devil duster. Here the bales are knocked apart, mechanically cleaned and fluffed up



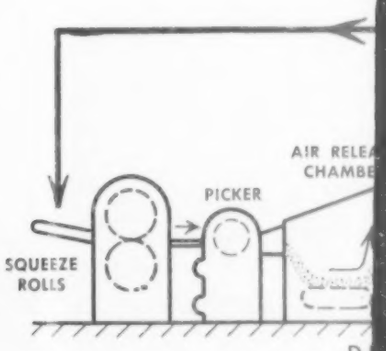
3 Some of the digesters. Linters are treated
sure with caustic to put foreign matter in a
dition so that it may be removed easily

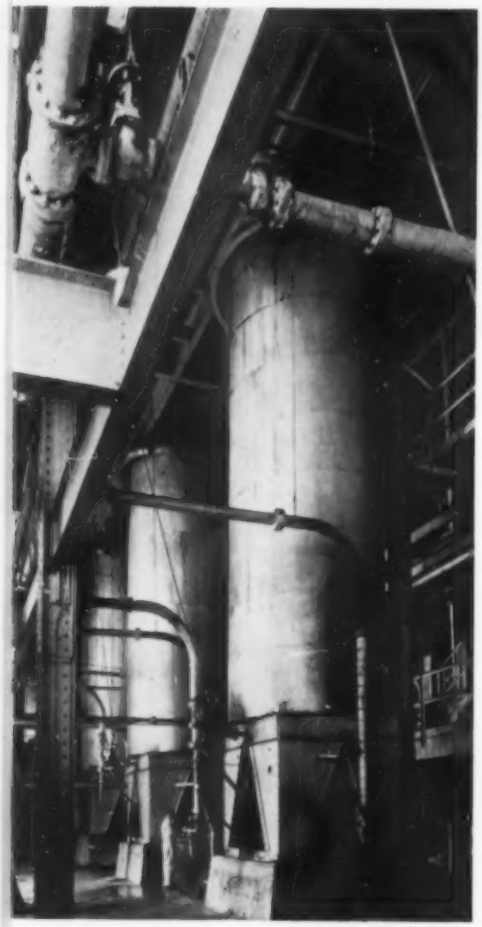
PURIFICATION AND BLEACHING FOR BOTH LOOSE AND SHEETED





4 Stainless steel lined wooden tubs in which linters are given several mild bleach treatments. The practice of multiple stage bleaching is found to be more satisfactory than a single stage bleach as fibers must not be attacked





the digesters. Linters are treated under pres-
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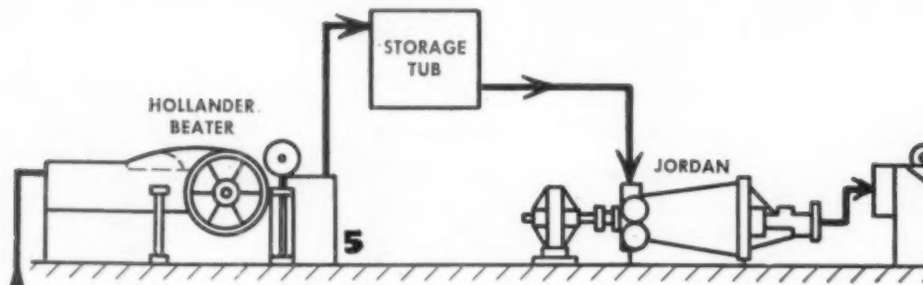
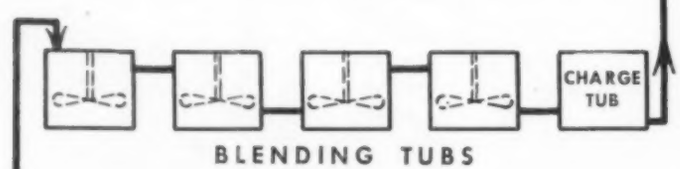


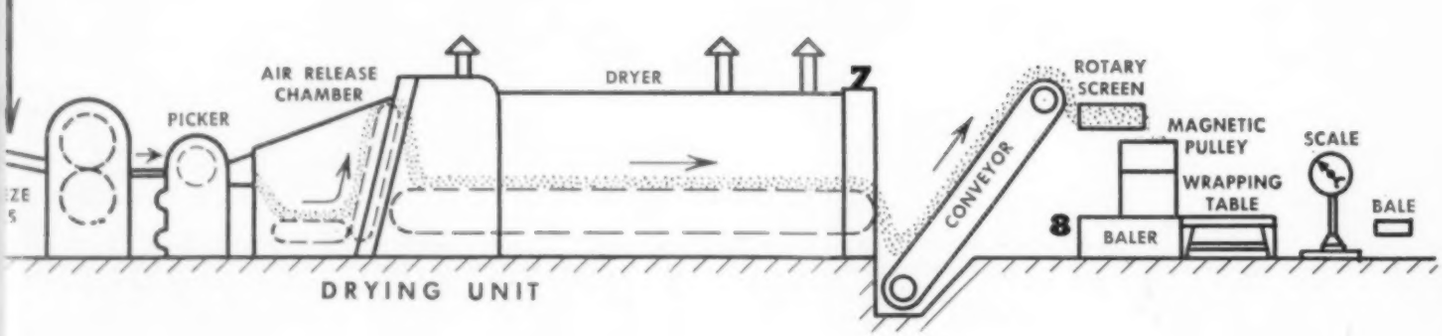


PRODUCTION OF
SHEETED CHEMICAL COTTON

5 Linters destine
sheeting departm
hollander beaters

From Purification Building

FINISHING
LOOSE CHEMICAL COTTON



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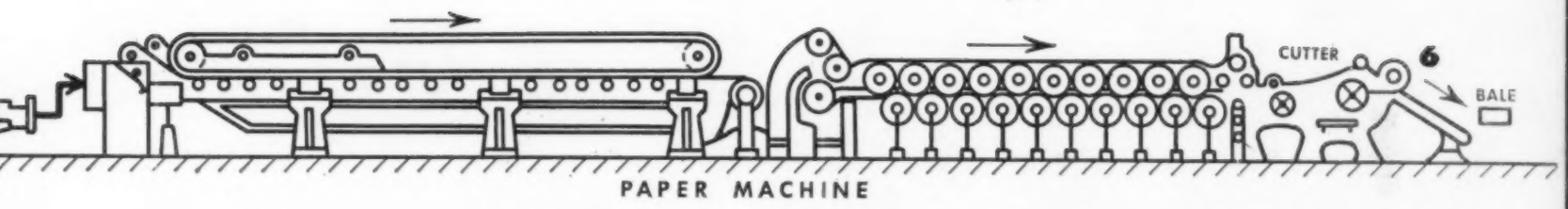
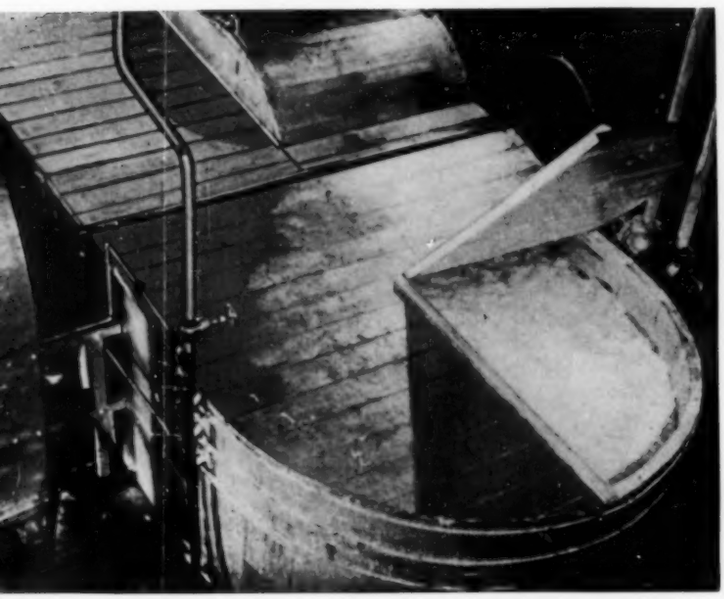
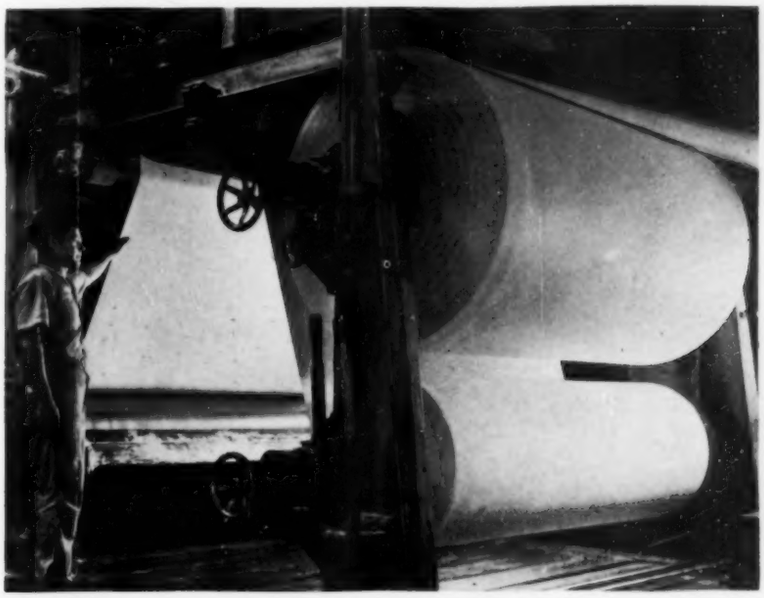


PAPER MACHINE

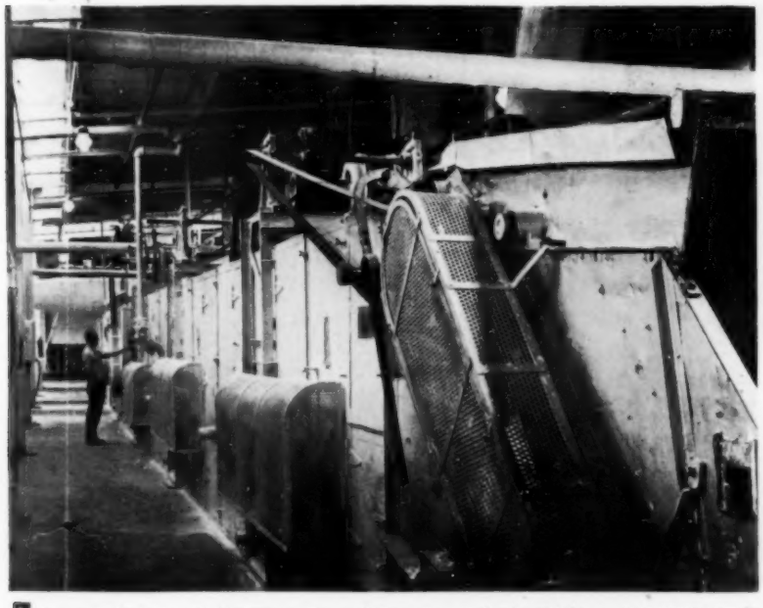


Linters destined to be converted into viscose rayon are pumped to the eting department where they are blended to assure uniformity. The lander beaters are covered to keep out foreign substances

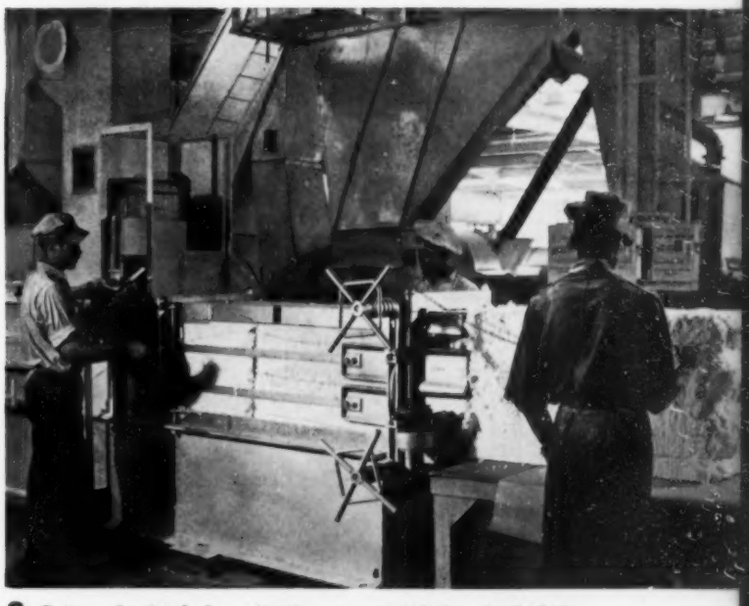


6 Refined linters are made into sheets on a fourdrinier paper machine. The temperature of the rolls of the machine is kept so low that the cellulose will not be harmed. Sheets are baled, weighed, wrapped in paper and shipped

BALE



7 Loosened cotton falls onto a travelling screen bed which carries it through a tunnel dryer in which the moisture is removed by a current of hot air, the temperature depends upon the use to which the cotton is to be put



8 Cotton destined for nitration or acetylation is baled in loose form and wrapped in kraft paper, weighed, picked up on skids and sent to the loading platform

In the center of the Chemical Process Industries,—DURIRON

Not only is *Duriron* in the center geographically, but *Duriron is* the center for corrosion-resisting alloys and equipment to meet the demands of the process industries.

And the demands are many and varied.

For instance: in the production of high explosives, sulfuric acid, nitric acid, mixed acid of various degrees of concentration and temperature require such alloys as *Duriron* and *Durimet* in equipment such as pumps, valves, towers, condensers, etc.: the rayon industry employs standard equipment of *Durimet* and special equipment of other *Durco Stainless Steels:* the refining of petroleum products in certain phases makes use of *Durichlor* equipment to handle chlorine and its compounds; in other phases, *Duriron* and *Durimet* equipment for sulfuric acid as used in acid-treating of distillates.

Most of you readers of *Chem & Met* know of The Duriron Company. Are you making full use of all the Duriron Company has to offer you?

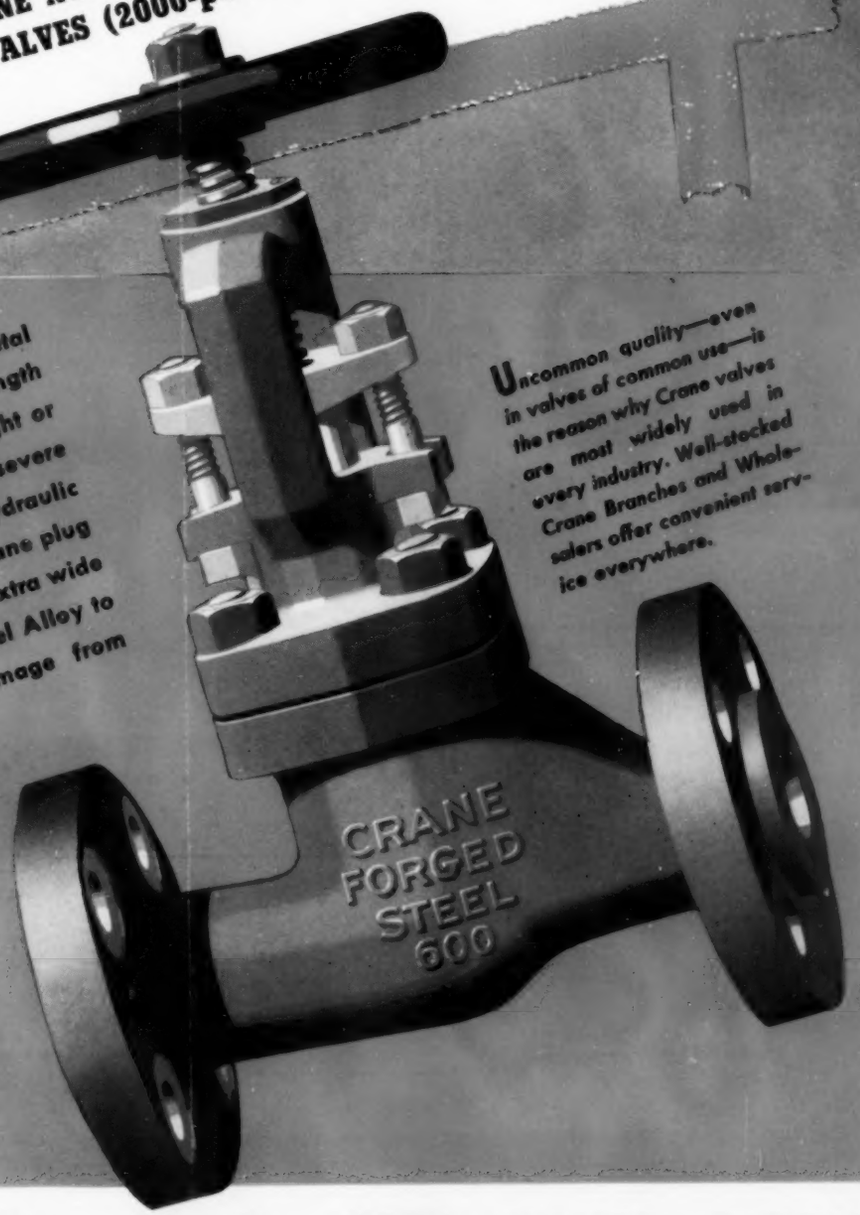
We shall be glad to send you technical bulletins on our alloys and equipment for corrosion-resisting purposes, if you wish them.

The DURIRON COMPANY, Inc.

For Safety's Sake!

IN HIGH PRESSURE LINES TO PRESSES

CRANE No. 3656-XR FORGED STEEL GLOBE VALVES (2000-pound, Cold pressures)



SCIENTIFIC distribution of metal gives these valves great strength in every part. No excess weight or bulk. They easily withstand severe service encountered in hydraulic and air lines to presses. Crane plug type seating design with extra wide bearing surfaces of Nickel Alloy to Exelloy minimizes damage from wire drawing and foreign matter; assures lasting tight closure.

Uncommon quality—even in valves of common use—is the reason why Crane valves are most widely used in every industry. Well-stocked Crane Branches and Wholesalers offer convenient service everywhere.

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VALVES • FITTINGS
PIPE • PLUMBING
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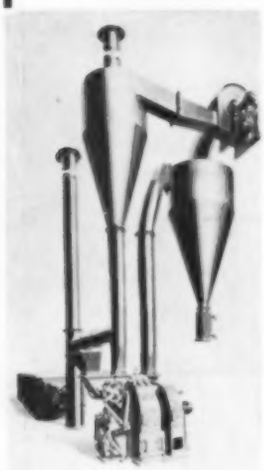
RAYMOND *Specialized Equipment for* CHEMICAL GRINDING

Today's "all-out" efforts to maintain maximum production make it more necessary than ever to install specialized equipment, carefully engineered to the job and capable of delivering high capacities of uniform finished materials.

Raymond pulverizing and separating machinery provides a full line of modern, automatic units for a wide range of grinding problems. These machines give close control over the product, and assure dustless operation. A few of the many units available are shown here.

IMP KILN MILL



Equipped with flash drying system for removing moisture from the material while pulverizing, and delivering the product in dry, powdered form.

•

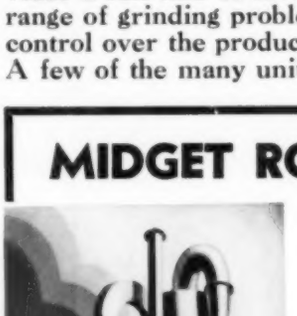
For removing water of crystallization from hydrate compounds and evaporating surface moisture from food products, chemical filler materials, fullers earth, diatomaceous earth and other products.

For re-grinding and drying acid treated clay

For drying and pulverizing Steamed Bone, and other organic products

Also for cooling and grinding operations

MIDGET ROLLER MILL



For finish grinding operations. Capable of producing extremely fine materials at record low cost per ton. May be equipped with whizzer separator for pigment grinding and similar operations.

•

Typical products:

Bauxite
Barytes
Talcs
Clays
Soapstone
Pigments
Chemicals

SCREEN PULVERIZER

Compact swing-hammer type mill for grinding and classifying soft materials to a fine powder. Available in six sizes.

LABORATORY MILL

For tests and development of new products, as in pulverizing samples for analysis. Will handle a few pounds at a time, producing same character of finished material as large pulverizers.

Write for Bulletins, stating type of equipment you need

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Timesaving Ideas for Engineers

Chem & Met PLANT NOTEBOOK

AQUA AMMONIA SOLUTIONS—THEIR FREEZING POINTS AND FREEZE-RESISTANT APPLICATIONS

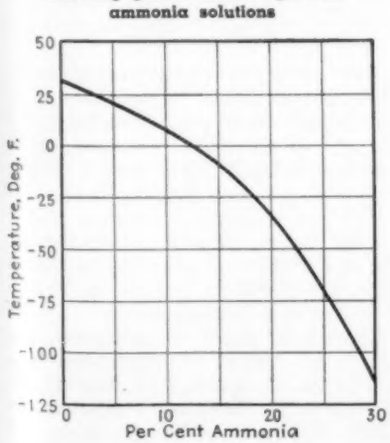
E. R. WOODWARD Chemical Engineer, New York, N. Y.

USERS of aqua ammonia are often faced with the problem of determining the economical quantities in which this material should be purchased. The aqua ammonia of commerce, which is a byproduct of the distillation of coal, is sold in two grades, Grade A ammoniacal liquor, containing at least 29.4 percent NH_3 and grade B, containing a minimum of 25 percent NH_3. The three types of package used for transporting ammonia are the Jumbo cylinder for anhydrous ammonia, containing 150 lb. of NH_3; the anhydrous ammonia tank car, containing 52,000 lb. of NH_3; and the aqua ammonia tank car, which holds the equivalent of 22,000 lb. of NH_3. Those users of aqua ammonia who consume 22 tons or more of this material per year find it more economical to buy by the tank car load.

In addition to the savings that are possible in purchasing tank car lots, there is economy in bulk storage of the ammonia, with an efficient piping system for distribution from the centrally located storage tank to the various using points in the plant. However, in considering the use of such a central storage point, it is necessary to take account of the possibility of freezing of the ammonia in the exposed piping during cold weather. Solutions containing less than about 18 percent NH_3 may freeze in weather met in many regions.

The earliest work with which the author is acquainted on the freezing points of aqua ammonia solutions was that of F. F. Rupert, University of Kansas, in 1909, who reported on the solid hydrates of ammonia (*Chem. Abs.*, **3**, 1909, 2418). Presumably later data are those in a chart published by the American Society of Refrigerating Engineers (Refrigerating Data Book, Vol. I, 1939, p. 46) in which a complete freezing point curve for all concentrations from 0 to 100 percent NH_3 is given. The accompanying curve, covering concentrations from 0 to 30 percent, shows a freezing point of about —115 deg. F. for the 30 percent solution. Beyond a concentration of 30 percent, maximum freezing points occur at 48 percent NH_3 (—112 deg. F.) and 66 percent NH_3 (—110 deg. F.). Eutectic points occur at about 33 percent NH_3 (—150 deg. F.), 56 percent NH_3 (—130 deg. F.) and 80 percent NH_3 (—135 deg. F.).

Freezing points of 0-30 percent ammonia solutions



Applications

Ammonia has a number of interesting uses related to its lowering of the freezing point of water.

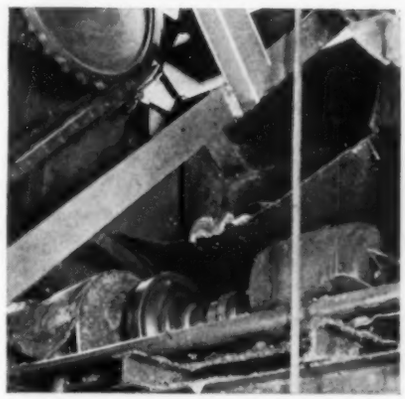
1. Anhydrous ammonia can be used as a thawing agent to clear frozen water pipes. By connecting a cylinder of the anhydrous material to the system and passing in NH_3, the heat generated by the solution of the gas, and its rapid diffusion into the ice, will greatly assist the thawing.

2. In gas pipe lines operating at 400 lb. or more the problem of maintaining flow in cold weather is complicated by the formation and freezing of the natural gas hydrates. The build-up of "snow" in the line results in progressive decrease of gas pressure. Laboratory and field tests made by one of the pipe line companies have shown that the presence in the gas of 42 parts of NH_3 per million (volume) will inhibit freeze-ups, owing to the displacement of the equilibrium between natural gas and condensed water vapor.

3. Aqua ammonia has been suggested as a cold transfer medium in place of the brines now used in refrigerating systems. In this connection it has some interesting properties and advantages, being efficient, and non-corrosive to ferrous metals.

Pyrometer Vibration Cure

A NOVEL AID in improving the performance of an automatic recording pyrometer, the records of which are used in controlling the operation of a rotary lime kiln, has been noted by the B. F. Goodrich Co. Vibration of the instrument made accurate readings impossible and temperature changes could be spotted only with difficulty. By mounting the instrument panel on vibration insulators of the Goodrich company's No. 10 type, and by supporting the booth in which the panel is housed on the No. 10 and No. 11 types, vibration and consequent distortion of the readings have been eliminated.

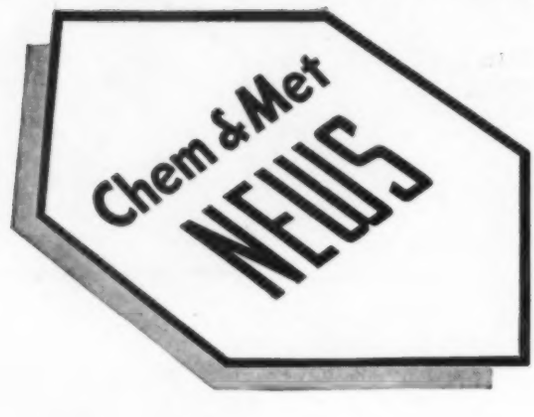


Hydraulic coupling which cured the conveyor drive stoppage

Solving a Conveyor Problem

AN INTERESTING conveying problem was recently solved in a plant handling a bulky material which had the habit of accumulating ahead of the conveyor at times, then breaking loose and jamming the conveyor. The first solution employed in attempting to take care of this difficulty was the installation of a shear pin in the conveyor drive. However, at times the pin was broken as often as five or six times a day, causing a temporary shut-down for replacement of the pin.

Until recently the operator replaced the broken pins himself, but this was discovered by the local union, which insisted that the job was one for a millwright. To eliminate the problem of continued delays, and the expense of sending for a millwright each time the conveyor jammed, the plant engineer decided to alter the drive so that no one would have to replace shear pins from that time forward. What he did was to have a small hydraulic coupling, of the type made by American Blower Corp., installed between the motor and the conveyor drive. With this flexible driving means interposed, the suddenly descending load may now stall the conveyor, or it may simply reduce its speed temporarily. In any event, no harm will be done.



News from Washington

WASHINGTON NEWS BUREAU, McGRAW-HILL PUBLISHING CO.

TIGHTENED controls on many phases of industrial activity have become evident in Washington during March. If one listened to some of the loose talk about the Capital City he would think that the present regulation by officials was even more rigid than during 1918. Actually some of the plans contemplated for application when the need comes may be of such unprecedented and drastic form.

At the beginning of April several commodities were subject to rigid priority control. Among them were aluminum, magnesium, neoprene, and tungsten. Other commodities were being rationed according to a system only slightly less formal than the priority programs. Included in this group at the first of the month were zinc, copper, nickel, and a number of secondary metals. Both lists will grow rapidly in the near future.

New Style Contracts

Two new factors make probable an extension of government contracts to many firms that have not heretofore thought themselves likely to get so involved. One of these factors has to do with the way in which new projects are being financed. The other factor comes from the fact, now obvious in Washington, that the government must deal with many more companies of moderate or small size. It cannot go on much longer with the huge multi-million projects which only big units of industry could handle.

Already several old and stable but relatively small companies are discussing ammonia contracts with OPM. These new projects involve small plants of twenty-five to one hundred tons per day. Even the smallest contribution to the ammonia capacity of the country is welcomed. This means that many firms which might do something like this in a modest way can now come down and not only get consideration, but enthusiastic welcome and help.

Not a negligible factor in all this trend is the fact that already Washington notes a shortage of skilled and experienced managements able to take on new business. Many divisions of chemical process industry have already exhausted almost all their reserves of managerial talent. Officials therefore know that they must call on more companies and among them many small firms that can take on new business only if it could be reasonably interlocked with their regular activity.

Rationing Formula

First application of official government rationing of raw material supplies to non-defense as well as defense uses is being tried out this month with aluminum. The broad outline of the pattern is fairly clear but, admittedly, application of the formula to some 50,000 or more orders is forcing a trial and error approach.

The method with respect to aluminum takes on importance beyond the effect in this field because it is expected to be the pattern followed, more or less as individual cases require, with other commodities as the priorities list lengthens. As in March, aluminum deliveries for defense account get the "A" preference ratings. These are now applied by the Army-Navy Munitions Board on government (including aid-to-Britain) orders, by OPM's Priorities Division on non-government defense orders. Defense orders without higher rating automatically are assigned an A-10 rating.

With defense needs cared for, producers (not fabricators) next must set aside under a B-1 rating a reserve pool of one percent of production each month; from this emergency stockpile the Priorities Division will fill unexpected needs. Then comes the allocation and rationing of non-defense orders.

Ratings from B-2 to B-8 are set up for this purpose. B-2 is applied to all orders for repair or replacement parts for existing apparatus needed for essential sevices and to maintain maximum production, such as for electric utilities or telephones. These are allotted for the time being 80 percent of their 1940 average consumption.

In the B-3 category fall orders for products essential to public health and safety, including collapsible aluminum tubes for toothpaste and pharmaceuticals. These get 70 percent of 1940 supplies. Next B-4, is for standard apparatus which cannot be redesigned for substitutes without serious dislocation and for which there is substantial use in defense channels, to which 60 percent of 1940 supplies are allocated.

Consumers using less than 1000 pounds monthly, irrespective of product, get a B-5 rating and 50 percent of last year's volume. Specifically designed to keep as many workers as possible at their jobs is B-6, applying to articles in which the metal doesn't exceed two pounds per $100 of final sales value. This category was written particularly for auto manufacturers. Forty percent of 1940 supplies is rationed to this classification.

B-7 rating goes to articles for which no reasonable substitute exists, the ration allowance being 30 percent of 1940 use, while B-8 is a catch-all rating for products for which reasonably satisfactory substitutes are available. This rating is cut to 10 percent of 1940 consumption.

The ration percentage table applicable to various non-defense classes is temporary and subject to continual changes to fit amount of the metal available for non-defense uses. The first ration schedule applies to April deliveries at least.

The Priorities Division order creating these seven non-defense classifications directed producers, fabricators and smelters to apply the rating formula to their individual orders for April delivery and submit the delivery schedule to OPM. Whether it will remain practical for the sellers to apply the formula or whether OPM will supplement its rating definitions with a "dictionary" of products assignable to each classification was uncertain early in April. The latter procedure probably will develop, informally at first and later on a formal basis.

Munitions Plants

The Army's projected second chain of munitions plants, to provide powder and ammunition production capacity for a four million-man combat force, has been merged with the production expansion program planned to be built under the lend-lease program. Total of the combination is $1,300,000,000 for new operations, plus slightly more than $200,000,000 more for additions to the present enlargement.

Immediate result of the consolidation of the two plant schedules at the end of March was the "scrapping" of the Army's tentative allocation of funds for its own second series of

plants. With the two plant lists dovetailed, new division of the larger fund by types of operations was being made. A large share of the total money is certain to go into production facilities for guns and tanks and planes, but the expansion of powder and ammunition facilities in the chemical field will not be reduced by this new program.

Money available for plant expansion —chemical type as well as others— comes from two sources. The Army has been allotted $765,000,000 in new funds and the British-aid appropriation carries $752,000,000 more. Of the Army fund, $137,500,000 (15 percent) is earmarked to meet rising costs of materials, labor and equipment on plants already under construction. Another $75,000,000 is for additional aircraft plant needed to round out the first stage of the defense program.

For the $549,000,000 left, the Army had made a tentative division by types of munitions, which generally speaking, duplicated the present munitions program to reach the objective of a four million-man force. When the aid money became available, it was decided that the two funds would stretch considerably farther if needs of the joint program were dovetailed instead of building for each goal separate. Another important consideration leading to this answer was the conservation of available management which in many lines of this program already is heavily crowded.

As previously explained in these columns, the bulk of these new plants are going west of the Mississippi and east of the Rockies. The South also will be given a goodly volume. Pointing up this policy was the establishment late in March of a Plant Site Committee within the OPM framework to advise with the Army (and Navy) on locations of new facilities. This committee, in a statement of policy, said that not only strategic security and efficiency, but also important permanent consequences for economic life of different parts of the nation are involved in selection of sites.

A four-point set of principles to guide these selections calls for avoidance of cities or regions where defense orders placed with private industry are expected to require the entire labor market; for preference of areas with reserves of unemployed where industrialization will contribute to a better long-run balance of agriculture and industry; for depression hit areas where industrial sections must be utilized; and for widest possible distribution of defense work. The statement added that both the South and the West have many areas falling in the second category.

The committee will not initiate plant sites, but will confine its work to reviewing sites selected by the Army and Navy and to advising with the military as to locations which are good and those that are bad for more facilities. Members of this committee are Donald M. Nelson, OPM's director of purchase as chairman; Clifford Townsend, as agricultural and labor advisor; Eli Oliver, as labor relations advisor; E. F. Johnson and S. R. Fuller, both of OPM.

With the funds now available, contracts for the second stage of the plant expansion program may be expected to start shortly in the hope of getting much of the work started during the spring and summer, avoiding last year's program which was mostly delayed until winter time.

Changes in Priorities

Several technical changes have been put into effect in administration of priorities since they were put on a formal basis (see *Chem. & Met.*, March, '41, p113). Several of these changes increase the job assigned to the Army-Navy Munitions Board which issues the so-called "automatic" rating for critical materials needed for defense orders.

This order now has authority to carry preference ratings down to all steps of subcontractors, instead of just the first sub-contractor. Also the list of items under its jurisdiction now includes several raw materials for which overall priorities have been imposed— aluminum, magnesium, neoprene, etc. Ratings for these items from the board insure preference in delivery under the major priorities system applicable to all supplies of those commodities.

With the advent of the lend-lease program, the board now issues ratings for British and Canadian orders, a preserve previously handled by the Stettinius division. This authority is interpreted to include American orders for delivery under lend-lease.

With these changes has come an entire new set of priorities forms, all of them to be issued over the signature of Edward R. Stettinius, Jr. The board, however, will continue to issue the automatic ratings as an agent. There are forms for civilian orders for domestic use (for some a preliminary purpose upon which defense production depends), for Army and Navy preference ratings, for other governmental agencies (such as a turbine for TVA), and for foreign orders. All of these are issued through the Stettinius division except the second named type.

Chemical Miscellany

More Transport Controls—The I.C.C. has extended its jurisdiction over mechanics, loaders, and drivers' helpers engaged in interstate activity. This put these men under the same safety regulations as the drivers. They will be subject to the 60-hour week, 10-hour day rulings but relieved of the wage-hour overtime rules. All other wage-hour regulations (on pay rates) continue in force, however.

British Plant Sales—Washington believes that the sale by the British government of American Viscose Corp. properties is but the beginning of a series of such transfers. The United States government has taken over the British government plants for explosives and many of its contract obligations for other military supplies and equipment. All this is intended to release British funds for other use. It is a part of the policy of letting Uncle Sam foot all present bills for British operations in the United States.

Labor Troubles—Even the return to Washington of President Roosevelt could not alone settle the complicated labor controversy which developed in late March. The temper of the general public, badly strained by serious strikes, became evident to Congress. Irrespective of normal pro-labor or anti-labor sentiment practically all of official Washington reached the conclusion during the last week of March that defense plant operations must not be interfered with by any strikes, no matter what the normal merit of the cause might be. The order from Knudsen and Knox to Allis-Chalmers was but an indication of this thinking, with which every division of government seems strikingly in agreement.

Spending Power—Uncle Sam's disbursements are expected to reach practically two billion dollars per month by mid-year. Even if the highest estimates of prospective national income of individuals is reached later in the year, the disbursements by the Federal government alone are expected to exceed twenty-five percent of this total. Congress is expected to raise the tax bill for 1942 by at least two billion dollars above the 1941 levy on individuals and corporations. Most of this increased levy will be by changes in income taxes. The major trends of that new legislation will become evident during May. The new income tax will not begin to flow from either corporations or individuals until March, 1942; but certain new excise levies will be applied much sooner than that.

RIDGWAY ELECTED PRESIDENT OF ELECTROCHEMICAL SOCIETY

At the annual meeting of The Electrochemical Society, Inc., held in Cleveland, April 16-19, Raymond R. Ridgway of The Norton Co., Chippawa, Ont., Canada, was elected president for the ensuing year. Other officers elected were: vice-presidents—E. M. Baker, G. B. Hogaboom, Sr., M.deK. Thompson, terms expiring 1942 and Sherlock Swann, Jr., J. W. Marden, Malcolm Dole, terms expiring 1943; managers— C. E. Williams, K. G. Soderberg, J. A. Lee, terms expiring 1942, S. D. Kirkpatrick, A. K. Graham, R. L. Seabury, terms expiring 1943, R. M. Hunter, W. C. Moore, R. B. Hammond, terms expiring 1944; treasurer, R. M. Burns; and secretary, Colin G. Fink.

The Society's prize to young authors was awarded to Dr. Johnstone S. Mackay, Sun Oil Co., Marcus Hook, Pa., for his paper "Photoelectric Cells Sensitive to Long Wave Length Radiation." The thirteenth Weston Fellowship grant of $1,000 was made to Rodney E. Black who is working at the University of Wisconsin on plating baths for molybdenum and tungsten alloys.

ADVISORY STAFF TO STUDY DEFENSE CHEMICAL NEEDS

Commissioner Chester C. Davis of the Agricultural Division has made arrangements with Secretary of Agriculture Claude R. Wickard, whereby an advisory staff has been made available to P. H. Groggins, chief of the Agricultural Chemicals Section.

Among the important objectives of this section is the study of chemical requirements of the defense program insofar as they relate to chemicals used in agriculture, such as chemical nitrogen, phosphates, potash and insecticides, and fungicides; chemical and technological uses of products derived from agriculture, such as oils and fats, cellulose, insecticides, manufactured dairy products, plastics, etc.

Personnel of the advisory staff for agriculture includes the following men, all of whom are members of the staff of the Bureau of Plant Industry under Dr. E. C. Auchter: Dr. R. O. E. Davis, adviser on chemical nitrogen problems. Dr. Davis is acting chief, division of fertilizer research, and in charge of nitrogen investigations.

Dr. William H. Ross, adviser on mixed fertilizers. Dr. Ross is in charge of mixed fertilizer investigations, division of fertilizer research.

Kenneth D. Jacob, adviser on phosphate problems. Mr. Jacob is in charge of phosphate investigations, division of fertilizer research.

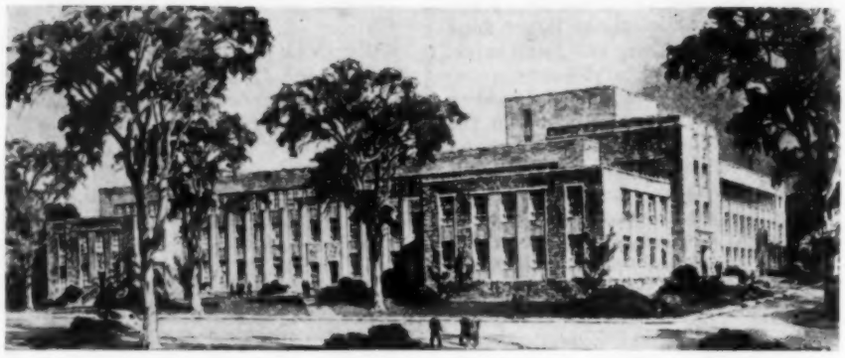
Dr. Kenneth G. Clark, adviser on potash problems. Dr. Clark is in charge of potash investigations, division of fertilizer research.

Arnon L. Mehring, who is temporarily attached to the staff of the Agricultural Chemicals Section, is responsible for the collection, tabulation, and interpretation of statistics with respect to chemicals needed both for fertilizers and munitions.

COLLEGES OFFER ENGINEERING COURSE FOR DEFENSE WORK

The U. S. Department of Education has formed the Bureau of Engineering Defense Training. This bureau has provided a number of educational centers, including about 40 colleges, at which students having at least two years engineering training will be given a 12-weeks course of study on explosives and amunition. Those successfully completing the course will be given a Civil Service rating and will be eligible for duty as inspectors and control chemists in munitions plants.

Originally it had been planned to send a professor from each of the colleges to the Massachusetts Institute of Technology for an intensive training under Prof. Tenny L. Davis. Owing to the illness of Professor Davis, Fred Olsen of Northwestern University was asked to undertake the work. Lectures were given at Washington University by members of the technical department of the Western Cartridge Co. Professors who attended the course were: C. T. Duncombe, University of Detroit; Albert O. Thompson, Massachusetts Institute of Technology; Eugene H. Eyster, California Institute of Technology; Professor Lacey, California Institute of Technology; C. E. Litkenhaus, University of Louisville; J. W. Green, Kansas State College; G. O. G. Lof, University of Colorado; Jules Bebie, Washington University; C. C. Lynch, University of Delaware; S. Y. Wiselogle, Johns Hopkins University; W. D. Turner, Columbia University; Vincent Eckstein, Brooklyn Polytechnic Institute; Paul K. Calloway, Georgia Institute of Technology; G. M. Smith, Vanderbilt University; Arnold Kitzes, University of Minnesota; R. Perry Barnes, Howard University; and Marcus Hobbs, Duke University.



Architect's drawing of Olin Hall of Chemical Engineering now under construction on the campus of Cornell University. This $700,000 structure, the gift of Franklin W. Olin, will accommodate 450 undergraduates and a number of graduate students. It will be completed this fall as the first of five buildings in the proposed new plant for the College of Engineering

TRADE DELIVERIES OF NEOPRENE WILL BE ALLOCATED

A General Preference Order providing for the April allocation of nearly 1,000,000 pounds of Neoprene has been announced by E. R. Stettinius, Jr., Director of Priorities, Office of Production Management. The Neoprene will go to approximately 250 companies and industrial users and will be used almost entirely for defense work. Mr. Stettinius announced that, in addition to the April allotments, a small quantity is to be set aside by the E. I. duPont de Nemours Co., Inc., sole producers of Neoprene, for laboratory and experimental purposes.

Neoprene was brought under mandatory control March 7. The later action strengthens and regularizes that control and, in addition, provides for the first case by case allocation of the product to industrial users. Under the March 7 order, the producing company was instructed to give all defense orders a preference rating of A-2 (thus putting them ahead of civilian orders without ratings), except as higher ratings might be assigned by the Priorities Division. It is stipulated that British defense orders are to be accorded the same treatment as United States defense orders, and orders for Great Britain requiring Neoprene are included in the allocations.

The order became effective on March 28 and will expire on June 30.

DuPONT BUILDING PLANT FOR SULFAMIC ACID

Dr. Wallace E. Gordon, Grasselli Chemicals Department of E. I. duPont de Nemours & Co., in an address to the New York Section, American Association of Textile Chemists and Colorists, announced that a new plant for the production of sulfamic acid was nearing completion at the duPont company's works at Grasselli, N. J., with operations scheduled to start May 15. He stated that although sulfamic acid had been discovered in 1878, it was a laboratory curiosity until three years ago when duPont developed a process for its manufacture and production on a semi-works scale has been carried out at Cleveland. He now classified it is a "tonnage chemical" with its most important application in fire retardant chemicals. It also is used in tanning and in dyestuff manufacture.

MISSOURI DEDICATES CHEMICAL ENGINEERING BUILDING

The newly completed chemical engineering and chemistry building at the School of Mines and Metallurgy, University of Missouri, at Rolla was formally dedicated on the afternoon of April 11. Governor F. C. Donnell greeted the guests and Senator F. M. McDavid accepted the building for the Curators of the University. Dr. Frank C. Whitmore, dean of the School of Chemistry and Physics at Pennsylvania State College, spoke on "The Accelerating Advance of Chemistry" and Dr. Harry C. Curtis, dean of the School of Engineering, University of Missouri discussed "Chemical Engineering Today and Yesterday". W. T. Schrenk is head of the Department of Chemical Engineering and Chemistry.

A Declaration of Independence

...FOR AMERICAN INDUSTRY

Chemical intermediates have become almost fully Americanized.

Described here are three Monsanto products which are helping to replace some of the rarer intermediates no longer available in sufficient quantities from abroad. Others on Monsanto's list which are serving similarly are para-anisidine, orthonitroanisole, benzyl chloride, phosphorus trichloride and orthoaminodiphenyl.

All of these as well as the better known Monsanto intermediates are available in ample quantities and at stable prices. Make Monsanto your headquarters for intermediates. MONSANTO CHEMICAL COMPANY, St. Louis, U. S. A.

Mol. Wt.
$Cl \cdot C_6H_4 \cdot NH_2 = 127.54$

ORTHOCHLORANILINE

Monsanto Specifications

Appearance: Light amber liquid. Darkens on standing.

Moisture: 0.1% Maximum.

Solubility in dilute HCl: Very slightly opalescent, maximum.

Crystallizing Point: Minus 2.3° C., minimum.

Distillation Range: 208.0° C. to 210.0° C. (95% within 1.0° C.)

Assay: 99.0% minimum.

Weight per gallon: 10 lbs. (approx.).

Mol. Wt.
$Cl \cdot C_6H_4 \cdot NH_2$

METACHLORANILINE

Monsanto Specifications

Appearance: Clear, light yellow liquid.

Moisture: 0.1% maximum.

Crystallizing Point: Approximately minus 10.0° C.

Distillation Range: 228.0° to 231.0° C. (95% within 1.0° C.).

Assay: 99.0% minimum.

Weight per Gallon: 10 lbs. (approx.).

Mol. Wt.
$Cl \cdot C_6H_4 \cdot NH_2$

PARACHLORANILINE

Monsanto Specifications

Appearance: Yellowish white solid, having a slight yellow color when melted.

Moisture: 0.1% maximum.

Solubility in dilute HCl: Slight opalescence.

Crystallizing Point: 69.5° C. minimum.

Distillation Range: 229.0° to 233.0° C. (95% within 1.5° C.)

Assay: 99.0% minimum.

Weight per Gallon: 11 lbs. (approx.).

MONSANTO CHEMICALS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

ADVISORY COMMITTEE FORMED FOR PAINT AND VARNISH

A broad campaign to insure the defense program against delays due to shortages of essential paints, varnishes, or lacquers was launched Saturday morning, March 29, when representatives of all sections of the industry met with defense officials at the Office of Production Management, Donald M. Nelson, Director of Purchases, OPM, announced.

Under the general supervision of Donald G. Clark, chief of the equipment and supplies branch of the Division of Purchases, and J. B. Davis, his special adviser on protective coatings, an advisory committee was set up through which the industry and the government can work together both to solve defense problems in respect to protective finishes and to fill defense needs with a minimum of disturbance to the civilian trade.

GLASS COMPANIES ANNOUNCE EXPANSION PROGRAMS

Owens-Corning Fiberglas Corp., Toledo, has announced the purchase of the Lonsdale Co. mill in Ashton, R. I. The plant will be renovated and equipment installed by June 1 for the manufacture of Fiberglas. Some of the force now employed at Newark, Ohio, will go to Ashton to get manufacturing operations underway. The Ashton site was selected because it is in the Providence industrial area where there is a large demand for the company's product.

Owens-Illinois Glass Co. also has reported the acquisition of a site near Waco, Texas, upon which a glass container plant will be erected. The company recently purchased, through its subsidiary, Owens-Illinois Distributors, a warehouse site in Long Island City.

GOODRICH OPENS NEW PLANT FOR KOROSEAL PRODUCTS

The B. F. Goodrich Co. recently completed a new $3,000,000 plant at Akron which gives the company greater facilities for processing products from Koroseal. Dr. H. E. Fritz, manager of the synthetics division, stated that the new plant climaxes a program of capital outlays in the development of Koroseal in excess of $1,000,000. Situated at the main factories of the company, the new plant will augment present production facilities in treating fabrics, manufacture of cements and lacquers, and will initiate production of a special film for packaging materials. Raw materials for the new processing unit will be supplied from a factory built last fall at Niagara Falls and from the company's chemical manufacturing division at Akron.

VANCOUVER COCONUT OIL PLANT NEARS COMPLETION

Work on the new coconut oil plant at Vancouver, B. C., has been rushed to completion and the plant is ready to start operations. Sir Walter Carpenter of Australia is the sponsor of the new enterprise and boats of the Carpenter Line will be used to transport the copra. A lot of three thousand tons of copra which has been stored at Lapointe pier, Vancouver, and which is said to have been taken on the high seas by the British, may furnish the first supply for the new plant. P. S. Gilman of San Francisco, who has represented the Carpenter interests on the Pacific Coast, has been placed in charge of the plant.

AIR CONDITIONING EXPOSITION PLANNED ON WEST COAST

Business groups representing varied activities on the West Coast are taking a lively interest in the Pacific Heating and Air Conditioning Exposition, to be held June 16-20 in the Exposition Auditorium, San Francisco, under the auspices of the American Society of Heating and Ventilating Engineers.

Among products to be exhibited are: Air filters, draftless diffusers, humidifiers for offices and homes, temperature and humidity controlling devices, air flow regulators, safety valves, flame detectors for furnaces, electric and pneumatic systems for regulating the operation of remotely located machinery from the spaces to be conditioned, hot water heating appliances, window ventilators, and coolers.

An effective background for the Exposition will be formed by scientific papers, reports of committees, and professional discussions presented at the Summer Meeting of the American Society of Heating and Ventilating Engineers and the annual meeting of the Heating, Piping and Air Conditioning Contractors National Association.

CHIPMAN CHEMICAL PLANT WRECKED BY EXPLOSION

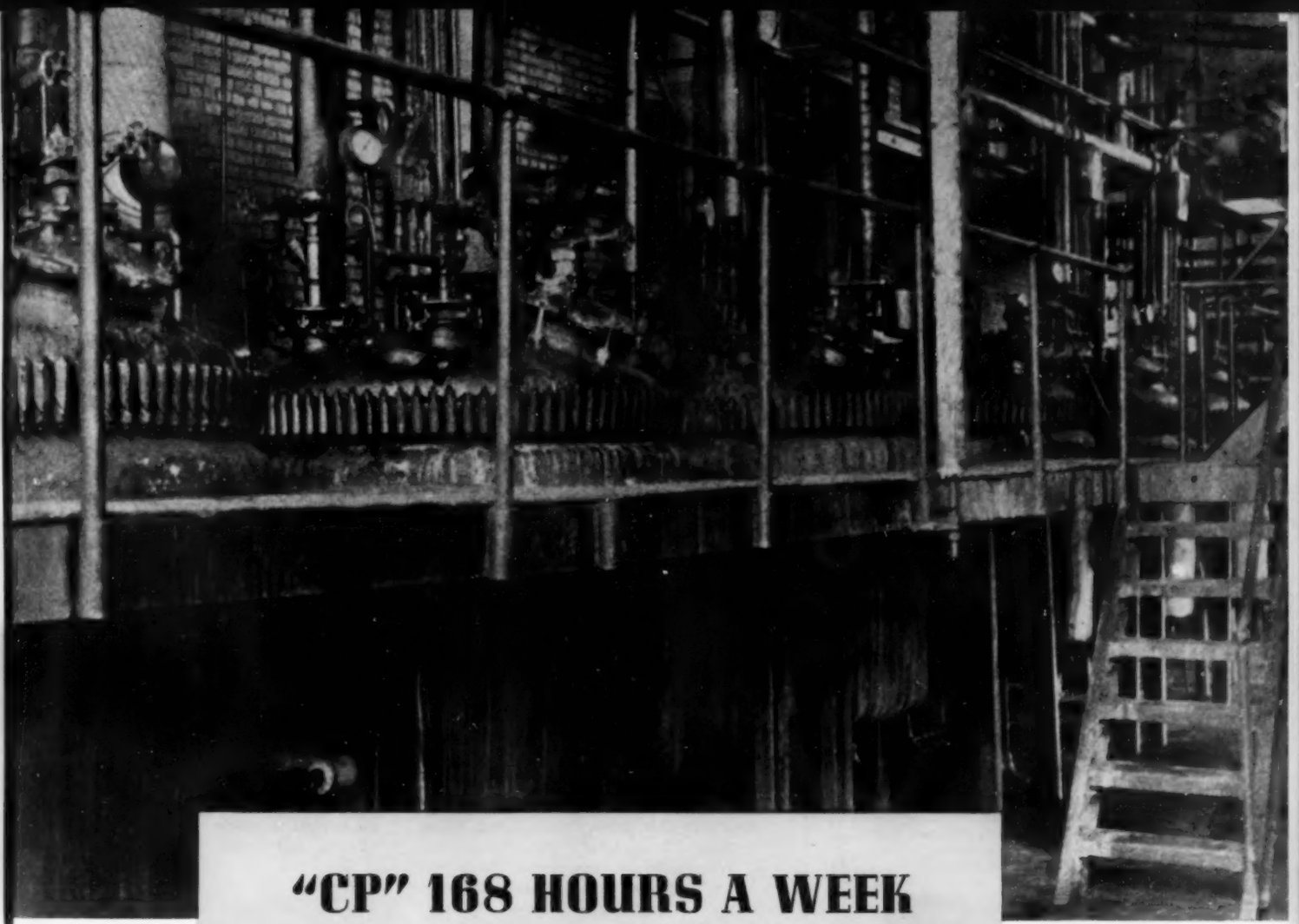
On March 25, the newly erected plant of the Chipman Chemical Co. at Portland, Ore., was destroyed by an explosion. A construction worker was killed and about a dozen employees of the plant were injured. Mr. Chipman, who had come on from Plainfield, N. J., only a short time previously, was included in the injured list. The loss is estimated at $50,000.

Factory Consumption of Primary Animal and Vegetable Fats and Oils, by Classes of Products, Calendar Year 1940

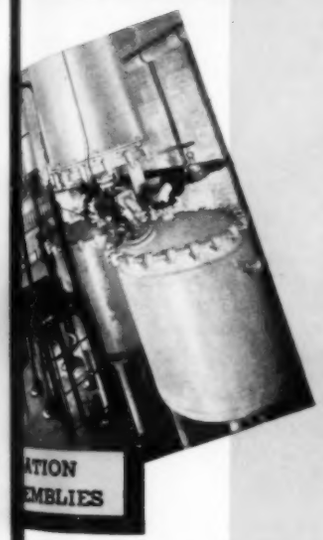
(Quantities in thousands of pounds)

	Total	Shortening	Oleomargarine	Other Edible Products	Soap	Paint and Varnish	Linoleum and Oilcloth	Printing Inks	Miscellaneous Products	Loss (including oil in foots)
Total	4,737,858	1,196,424	255,953	480,378	1,722,634	434,736	111,813	21,178	367,670	147,072
Cottonseed oil	1,279,960	823,350	115,947	263,323	2,971	65	.....	152	2,793	71,350
Peanut oil	39,530	22,516	1,728	9,743	387	.....	.....	.....	1,334	3,822
Coconut oil	528,203	17,576	21,783	54,689	396,857	1,261	.....	2	4,531	31,504
Corn oil	88,390	746	419	70,956	3,638	174	.....	.....	2,110	10,347
Soybean oil	431,641	212,317	87,106	39,980	17,612	29,828	7,254	82	16,538	20,924
Olive oil, edible	4,809	.....	.....	4,570	130	.....	.....	.....	109	.....
Olive oil, inedible	6,125	.....	.....	.....	1,637	7	.....	.....	4,481	.....
Sulphur oil or olive foots	15,884	.....	.....	.....	14,948	.....	.....	.....	936	.....
Palm-kernel oil	6,773	1,146	.....	4,772	197	.....	.....	.....	24	634
Palm oil	157,213	33,224	4	3,081	84,934	2	.....	2	*32,302	3,664
Babassu oil	55,481	381	6,148	5,759	41,221	.....	.....	.....	8	1,964
Sesame oil	1,343	24	.....	1,133	38	.....	.....	.....	34	114
Rapeseed oil	8,788	.....	.....	.....	49	88	.....	.....	8,651	.....
Linseed oil	386,225	.....	.....	.....	1,489	270,239	84,262	17,108	13,013	114
Tung oil	59,057	.....	.....	.....	.....	54,611	2,064	1,728	654	.....
Perilla oil	18,645	.....	.....	.....	.....	14,659	2,387	1,108	491	.....
Castor oil	54,046	.....	.....	.....	1,225	24,368	137	352	27,950	14
Other vegetable oils	23,369	32	.....	5,020	2,051	8,336	706	20	6,756	448
Lard	29,519	16,786	5,098	6,587	645	.....	.....	9	135	259
Edible animal stearin	27,073	16,940	3,387	5,926	549	.....	.....	6	231	34
Oleo oil	15,886	880	14,333	62	127	.....	.....	.....	453	31
Tallow, edible	46,750	39,595	.....	4,777	657	.....	.....	1	1,611	109
Tallow, inedible	884,685	.....	.....	.....	786,456	141	2	12	97,441	633
Grease	356,513	.....	.....	.....	256,886	94	.....	410	98,370	753
Neat's-foot oil	5,550	.....	.....	.....	19	28	.....	.....	5,498	5
Marine mammal oils	26,885	.....	.....	.....	19,250	48	.....	7	7,580	.....
Fish oils	179,515	10,902	.....	.....	88,661	30,787	15,001	179	33,636	349

* Includes 31,075 thousand pounds reported by the tin and terne plate industry.



"CP" 168 HOURS A WEEK



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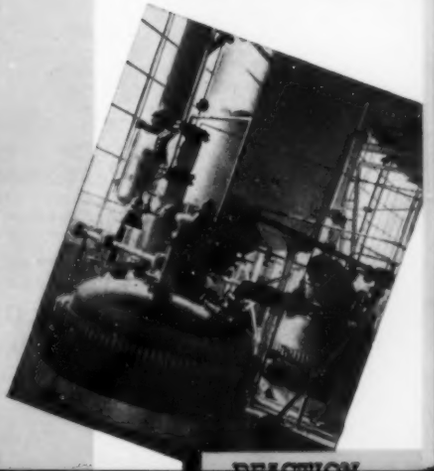
EMBLIES

"All-Out" Production—168 hours a week—leaves no time for equipment breakdowns or periodic overhauling. Furthermore, the product must be right the first time—without the necessity of re-working or re-running to eliminate impurities.

That's why more and more firms are specifying glass-lined steel equipment wherever acid conditions occur. Its smooth, non-adhesive surface is resistant to all acids (except HF), at any temperature or in any concentration. Your product is protected against metallic contamination. Equipment life is lengthened. Today, Pfaudler is meeting emergency conditions with the largest sizes, the greatest variety of shapes and the toughest, most acid-resisting enamels in its history.

If you haven't reviewed the "protection only glass can give" lately, let us bring you up to date. The advantages will surprise you.

DIGESTERS



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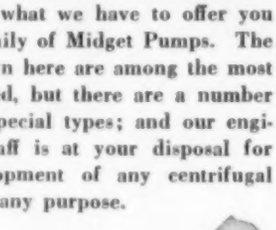
PFAUDLER

MAYBE IT'S ONE OF THESE THREE

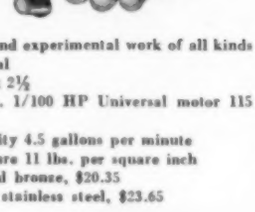
If circulating light liquids is one of your processes, then by all means look into what we have to offer you in our family of Midget Pumps. The three shown here are among the most widely used, but there are a number of other special types; and our engineering staff is at your disposal for the development of any centrifugal pump for any purpose.

MODEL A



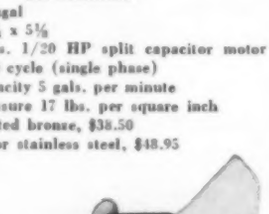
For laboratory and experimental work of all kinds
Type: Centrifugal
Size: 4¼ x 2¾ x 2½
Weight: 2¾ lbs. 1/100 HP Universal motor 115 volts A. C.
Maximum capacity 4.5 gallons per minute
Maximum pressure 11 lbs. per square inch
Chromium plated bronze, $20.35
Monel metal or stainless steel, $23.65

MODEL D



For continuous duty in industrial or laboratory operations. Sparkproof motor is safe under hazardous conditions
Type: Centrifugal
Size: 7¾ x 6⅜ x 5½
Weight: 14 lbs. 1/20 HP split capacitor motor 115 volts, 60 cycle (single phase)
Maximum capacity 5 gals. per minute
Maximum pressure 17 lbs. per square inch
Chromium plated bronze, $38.50
Monel metal or stainless steel, $48.95

MODEL E



For continuous heavy duty
Type: Centrifugal
Size: 6¾ x 3¾ x 3
Weight: 6 lbs. 1/20 HP fan-cooled Universal motor, 115 volts D. C. or 25-60 cycles A. C.
Maximum capacity 7½ gals. per minute.
Maximum pressure 20-25 lbs. per square inch
Chromium plated bronze, $29.15
Monel metal or stainless steel, $32.45

All Prices F.O.B. New Haven, Conn.

Send for our *MIDGET PUMP CATALOG* describing our entire line of Midget Pumps, and giving full specifications and performance charts.

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CONQUERED TERRITORIES CONTRIBUTE MUCH TO PAYMENT OF GERMANY'S WAR BILL

From Our German Correspondent

How the Reich is footing its war bill is indicated in a recent article in the "Deutsche Steuer Zeitung." Although detailed figures are not given, it is revealed that with a total Greater Reich national income approximating 100,000 million RM, Germany's wartime bill last year ran 68,000 million RM, and in 1941 will be appoximately 72,000 million RM. Tax revenues are expected to yield about 34,000 million RM, and 38,000 million RM will be raised by short-term loans rather than by long-term loans as in the last war. The total disclosed public debt increased by 19,000 million RM in the second half of 1940 to 79,000 million RM, which is still relatively lower per capita than other major powers, chiefly because after the 1923 inflation the bookkeeping started at zero.

After the invasion of Poland, Hitler disclosed that in the preceding five years Germany had spent 90,000 million RM in war preparation—without disclosing, however, whether road construction and such constituted military projects. Translated into current costs of United States production, labor and materials, one expert places this as equivalent to an expenditure of at least $75 billion by Germany over the five years before the war's outbreak. It has also been estimated recently that conquered territories, in addition to leaving Reich manpower free for military services, are contributing the equivalent of $1,275 million in resources and $400 million in supplies annually.

In Germany inflation has been kept latent by means of rigid controls on every branch of national economy. The tendency toward rising prices as the national income has increased has been kept in strict check by pegging all factors as prices, wages, currency, investment, etc. The costs of economic reconstruction and reorganization since 1938 in annexed areas have put quite a strain on Reich finances. In some cases large private corporations, as I. G. Farben, have taken over some of the costs of carrying out agricultural and industrial projects in less developed areas. The state-owned Hermann Goering concern has steadily taken over the job of reorganization in the annexed territories, especially in the coal and steel industries.

New apparatus recently described in the "Chemiker Zeitung" includes a new instrument developed by a Duisburg concern to determine continuously and semi-automatically with an accuracy within 0.1 percent the water content of any product during the manufacturing process. Another instrument for which a wide range of applicability is claimed is a new "Plastograph" to measure viscosity, plasticity, and the consistency of pasty, plastic, and high-consistency masses in industrial processes. A new invention in the metal industries is a pencil, similar to wax or color pencils, to measure high temperatures. A stroke with the pencil on the metal object to be tested accurately indicates its temperature in the range from 250 to 1100 degrees Fahrenheit.

A new method of determining by light electrolysis the phosphate and potash content of the soil, developed by Professor Neubauer of Dresden, is being applied widely in the Reich to determine fertilizer needs and thereby to increase soil fertility and agricultural yields. The electrical apparatus, it is claimed, works much more quickly and accurately than the older chemical tests. So far 70 agricultural research stations have already carried out 25,000 soil tests for farmers and plan to extend the service to 100,000 soon so that a constant survey of soil needs all over the country will be available to permit a more rational utilization of soil and fertilizers.

Attempts to raise production of vegetable oils are still being pushed. Besides increases in acreages planted in soybeans, sunflowers, etc. in the Balkans, in Germany the area sown in rapeseed, which totaled 80,000 hectares in 1939, is reported to have reached 225,000 hectares in 1940. More white lupine is also being planted. Through careful selection, the oil content of an improved white lupine has been doubled in the last few years, but an entirely satisfactory process for refining the oil or for getting a good fibre along with increased oil-seed yield has not yet been developed. A sidelight on the oilseed supply is the sharp rise in imports of copra from the Philippines to Valdivostok and of coconut oil from the Pacific coast to Vladivostok. That some of this might be reaching Germany could be assumed from the fact that Russian imports of oil-bearing seeds were formerly negligible.

Although German bee culture has increased considerably the past few years, before the outbreak of the war much honey and beeswax were imported, and Germany in turn re-exported considerable quantities of wax and wax products. Cut off from such sources of beeswax supply as Cuba, Reich candle manufacturers are now producing candles from paraffin and related brown coal derivatives instead of from beeswax. Most of the production of candles is by machine, although large altar candles up to 60 inches are still drawn by hand. Since the chief lignite deposits in the Reich are located near Leipzig, this city is becoming important as a candle center.

The central German lignite fields are also still a leading source of raw materials for synthetic motor fuels in Germany. At the Leuna I. G. plant near Merseburg, large-scale gasoline production from lignite began as early as 1927. According to a recent German estimate, the Reich is now producing more than three million tons of synthetic gasoline annually. In gasoline motor fuels since June 1939 tetraethyl lead has been used as a compulsory anti-knock agent to replace ethyl alcohol. For the manufacture of tetraethyl lead, ethylene bromide and lead sodium alloy are used. This has been one of the reasons why the production of sodium metal has increased rapidly in the past few years in Germany. Sodium consumption has also climbed as a result of expanded production of aluminum and magnesium alloys, of sodium metal vapor lamps for highway lighting, and for organic chemical syntheses. Sodium is used, for example, as a contact metal in producing certain types of Buna rubber by polymerization from butadiene gas, with the first two letters of the name, "BU," referring to butadiene and the latter two, "NA," to natrium, or sodium. A less common use for sodium metal in Germany is in the removal of traces of oxygen and moisture from rare gases like neon, helium, argon, and krypton.

Following successful introduction of non-toxic gas at the municipal gas plant at Hamlin, it is now reported by the Berlin Association of Gas and Water Supply Experts, that non-poisonous illuminating gas is being produced in the municipal gas works at Potsdam, near Berlin. It is claimed that the new process can be employed with no trouble and slight expense and can be used without changes in meters, burners, or gas pipe systems.

A new fumigant, trichloroacetic nitrile, marketed under the name "Tritox," is now on sale in the Reich for pest extermination. Due to a warning effect caused by irritation of the eyes, the gas is safe for human beings and red-blooded animals. Advantages in comparison with hydrocyanic acid and ethylene oxide are claimed to include its strong toxic effect for insects, non-flammability, rapidity of disinfection, and non-injury to wood, textiles, metals, painted surfaces, or dried foodstuffs.

For the chemical and other industries where electric wires are exposed to corrosion, moisture, solvents, and grease, a new type cable insulation has been developed by the Siemens-Halske electric works in Berlin. Telephone wires in chemical factories are being wrapped with silk and coated with synthetic resin to make them moisture proof and practically non-inflammable.

That Germany has apparently a more adequate supply of iodine than at the outbreak of the war is indicated in the recent removal of restrictions on the sale of iodine or iodine solutions by others than pharmacists. Iodine was one of the raw ma-

SUCCESSFULLY SOLVING PROBLEMS LIKE THESE...proves the value of Bemis Shipping Research

PROBLEM: Company losing business because product became lumpy.

(Lumping overcome and sales increased by new container "prescribed" after Bemis shipping research.)

PROBLEM: Moisture from air liquefied product which then caked.

(Bemis research provided proper protection and cut packing and shipping costs.)

PROBLEM: Product difficult to store due to moisture, bacteria and acid content.

(Overcome by Bemis research which also opened new market and lowered packaging costs.)

PROBLEM: Product lost weight in shipment.

(Better protection, resulting from Bemis research, prevented product from drying out and losing weight. Increased length of satisfactory storage.)

Let Bemis run a laboratory test on your containers

Bemis maintains a complete Shipping Research Laboratory in which your packaged products can be put through all the hazards of actual shipment and storage. Here, without obligation, we will check the efficiency of your containers, give you a complete report and advise you should we find any way your containers could be improved.

Write for complete details of this unique service which has helped scores of firms increase sales and profits through increased customer-satisfaction, and lowered shipping, handling and container costs. Also send coupon today for special brochure which gives the complete story of Bemis Waterproof Bags.

BEMIS WATERPROOF BAGS are also made ODORPROOF, SIFTPROOF, DUSTPROOF, LINTPROOF, ACID AND GREASE RESISTANT . . .

WATERPROOF DEPARTMENT
BEMIS BRO. BAG CO.
ST. LOUIS • BROOKLYN

BEMIS BRO. BAG CO.
415 Poplar Street, St. Louis, Mo.; 5106 Second Avenue, Brooklyn, N. Y.
Please send your special brochure and details about use of Bemis
Waterproof Bags for _____ (Product)
Firm Name _____
Street Address _____
City _____ State _____
Mark for the attention of _____

Its unique chemical resistance makes Causplit Cement a success where other cements fail. For Causplit readily handles a wide range of strong acids, alkalies and solvents at temperatures up to 350°F.

And Causplit is quick-setting, tough and durable, easy to apply, resistant to abrasion and to rapid changes in temperature. Proved admirable for corrosion-proof equipment lining in extensive industrial tests, Causplit Cement represents a considerable improvement over Penchlor Acid-Proof Cement and Asplit Cement, which have been successfully used in many industries for over 7 years.

CHEMICAL PLANTS profit by using Causplit because it resists hydrochloric, phosphoric and other strong acids, carbonates, sulfates and other salts, ammonia and various strong alkalies, phenol, toluol, alcohols, acetone and numerous other chemicals. Causplit Cement can be used in equipment handling alkalies and acids alternately—where other cements "wash out."

PAPER AND PULP MILLS find Causplit economical and durable for pulp digesters, bleaching system equipment, acid towers, recovery systems, etc. It withstands abrasion, repeated washings, sudden temperature changes, and chemicals used in the industry—including 50% caustic soda, soda ash, hypochlorites and chlorine, sulfurous acid, sodium sulfite, sodium sulfide, alum and others.

STEEL MILLS can use Causplit Cement for pickling, neutralizing and degreasing tanks and similar equipment because it is unaffected by sulfuric, hydrofluoric and hydrochloric acids, by strong alkalies, salts and solvents. Causplit maintains tight joints and preserves bricks, far outlasting other types of cement construction.

Wire or write today for FREE TEST KIT, including samples, booklet of information and test data showing Causplit's resistance to various acids, alkalies and solvents. Pennsylvania Salt Manufacturing Co., Widener Bldg., Philadelphia, Pa.—New York • Chicago • St. Louis • Pittsburgh • Wyandotte • Tacoma.

PENNSYLVANIA SALT MANUFACTURING COMPANY
Chemicals

terials, stocks of which were recently requisitioned by the Reich army "Kommandatur" in France. Other chemical raw materials likewise requisitioned at the same time were opium, arsenic, sodium borate, boric acid, agar-agar, toluol, sulphur, and phosphate rock.

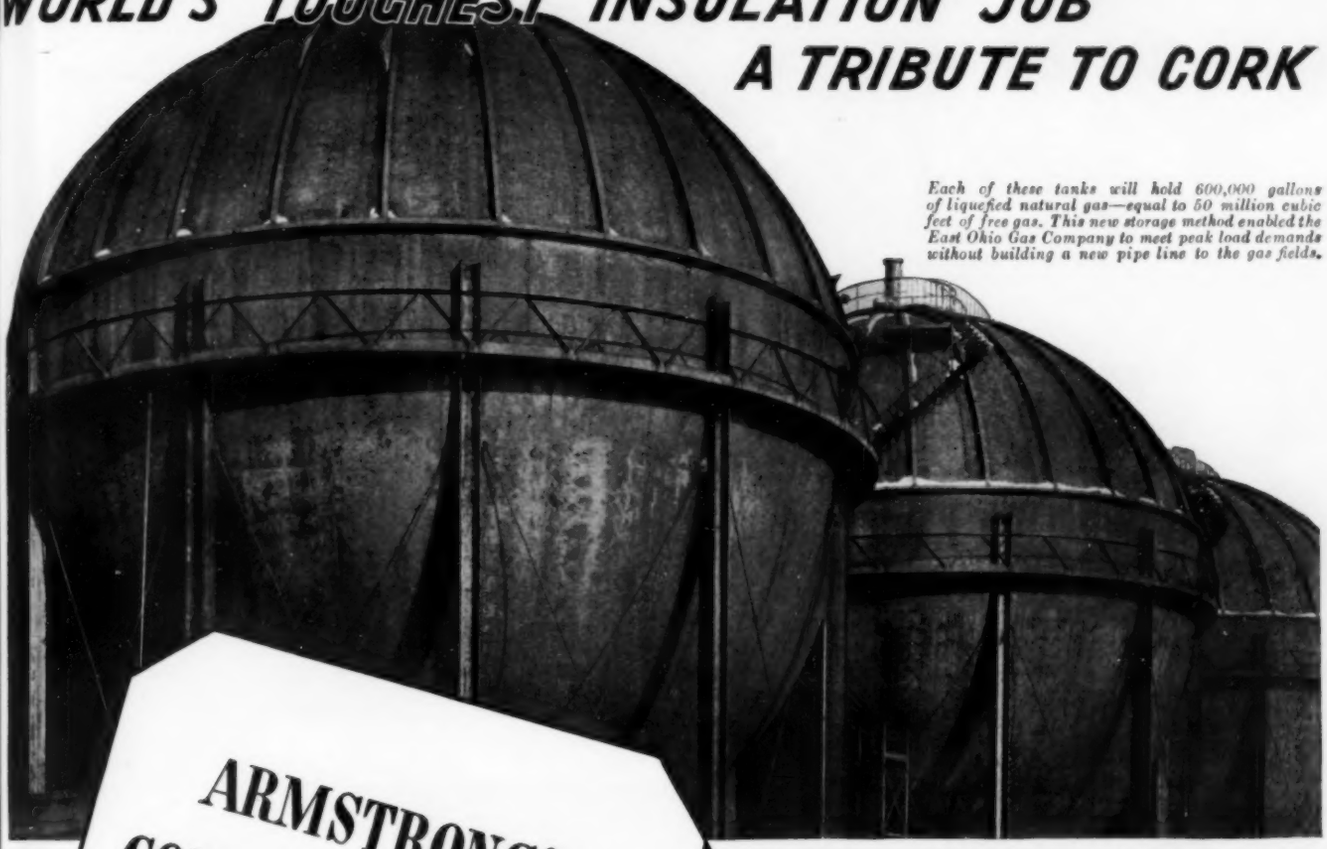
At the national Refrigeration Technique congress held recently in Vienna, results of experiments with a new substance, a synthetic resin foam called "Iporka" were reported. The new product, developed by I. G. Farben and tested in the Kaelte-Institut of the Karlsruhe Institute of Technology, is a condensation product of urea and formaldehyde in the form of sheets of solidified foam. It is resistant to decay and does not take on food smells, but it does absorb moisture unless it is coated. Glass fibers are added to increase its strength. Observations during one year's use of "Iporka" panels to line walls in the refrigeration plant of the municipal slaughter house at Offenbach a.M. indicate a promising future for the new material, according to a report in "V.D.I.," publication of the German Engineers' Society.

Quick-frozen meats and vegetables are being widely used for the German army, which is claimed to be better fed than in the last war. Highly concentrated foods and stimulants are being served aviators and submarine and tank crews. Soya bean meal has been added to enrichen various army foods, and more recently germinated rye, which has been found superior to milled rye, has been added to sausage and other foods served in the army. Surly-cabbage-, spinach-, carrots-, or onion-juice are added, for instance, to noodle dough to make various-colored noodles which include the food values of both noodles and the vegetables and save transport costs. In addition to dried fruits and vegetables, and dried sliced potatoes, new army diet items include sauerkraut, drier and compressed to brick form, powdered tomato soup, powdered apple sauce, powdered marmalade, and cheese-powder, to which water is added to restore them to normal edible foods. Roughage in the diet is provided by coarse bread and whatever fresh vegetables are locally available at the time. Experiments recently conducted at the army cooking school in Munich show, however, that soldiers still can turn in a better physical performance when they have plenty of fresh meat in their diet.

AIRCRAFT STEEL WELDING PRIZE CONTEST

The Summerill Tubing Co., Bridgeport, Pa., is establishing a series of prizes to be awarded by the American Welding Society at its annual meeting next October, for papers to advance the art of welding of aircraft steels including tubing and other parts for tubular assemblies. Awards will include one $300 prize, one $200 prize, and additional prizes totaling $100 for such additional papers as the committee of awards may direct.

WORLD'S TOUGHEST INSULATION JOB A TRIBUTE TO CORK



Each of these tanks will hold 600,000 gallons of liquefied natural gas—equal to 50 million cubic feet of free gas. This new storage method enabled the East Ohio Gas Company to meet peak load demands without building a new pipe line to the gas fields.

ARMSTRONG'S CORK INSULATION CHOSEN TO HOLD 258°F. BELOW ZERO!

This view shows a 36" thick layer of Armstrong's Corkboard installed around the lower half of the storage tank. An inner sphere to hold the liquefied natural gas at minus 258° F. was installed on, and is entirely supported by this dependable corkboard. Armstrong's Regranulated Cork, also in a 36" thickness, was used to insulate the upper half of the sphere.

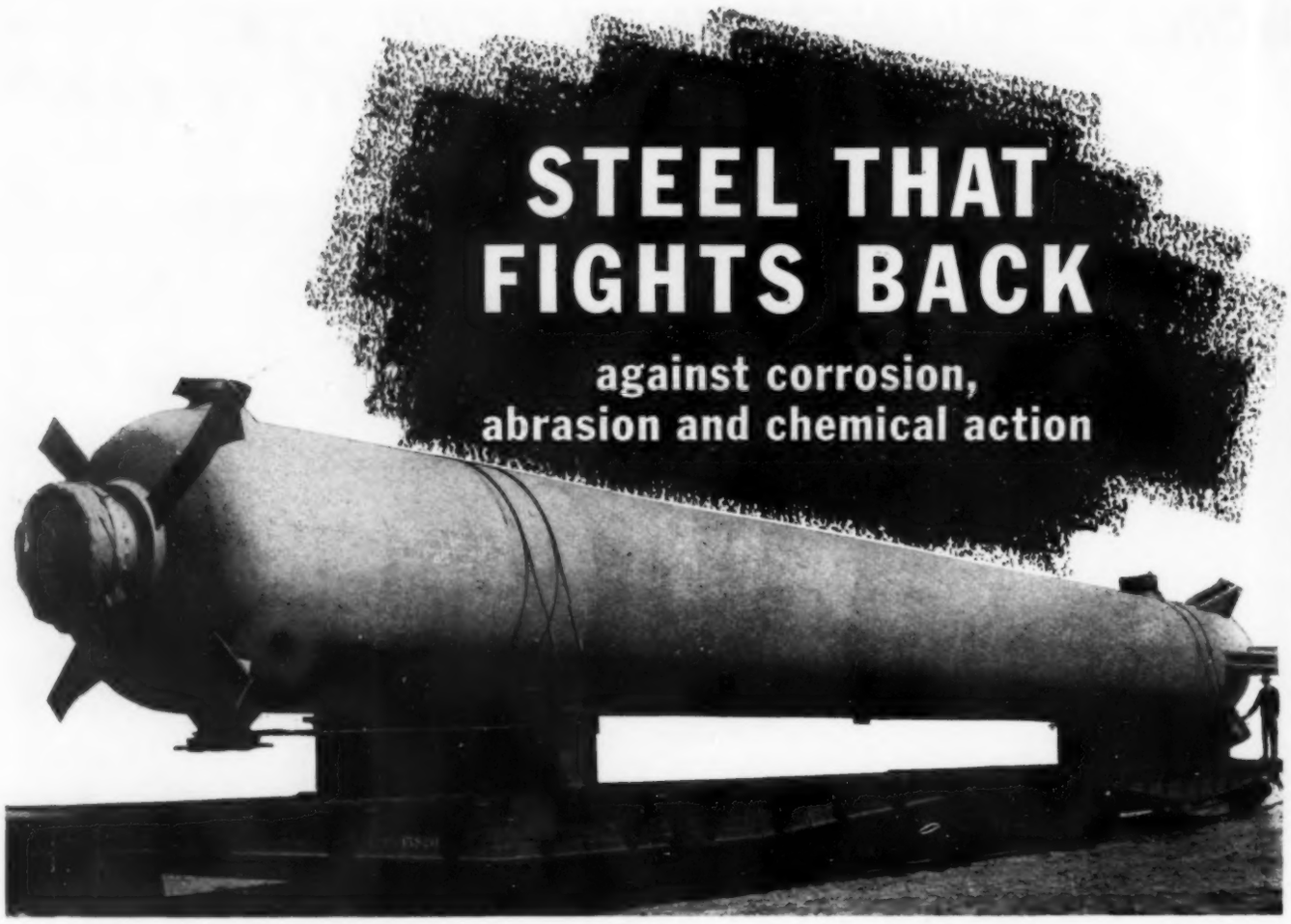
THE toughest insulation job we've ever heard of—guarding huge tanks of liquefied natural gas at minus 258° F.—was recently entrusted to cork. Armstrong's Cork Insulation was chosen because of its record for efficient and dependable service on other jobs involving extremely low temperatures and because of its outstanding natural properties such as its cellular structure, resistance to moisture, structural strength, and low thermal conductivity.

The unique tanks requiring this insulation are the heart of a new natural gas storage system designed to enable gas companies to meet peak load demands without building costly new pipe lines. The system was developed by the Hope Natural Gas Company and the first commercial plant was recently completed by the Gas Machinery Company for the East Ohio Gas Company, Cleveland.

This plant has three huge tanks, each made up of two concentric spheres separated by 36" of Armstrong's Cork Insulation. The inner sphere is 57 feet in diameter and rests directly on the corkboard which insulates its lower half. The upper half of the sphere is insulated with regranulated cork. An engineer's report on this unique installation, described cork as "The best heat insulator we have found . . ."

Whenever you need efficient, dependable insulation, whether for moderate or extremely low temperatures, come to Armstrong for advice. Write now for all the facts to Armstrong Cork Co., Building Materials Division, 919 Concord St., Lancaster, Pa.

ARMSTRONG'S CORK INSULATION



Alloy Lined Tower, 7 ft. diameter by 84 ft. 9 in. long for Chemical Service. Built by A. O. Smith Corporation, Milwaukee.

Ryerson Certified Steels Ideally Serve Exacting Chemical Requirements—and They're In Stock for Prompt Shipment

Steels specially made to fight back hard against the enemies that attack them in chemical manufacturing industries . . . . steels that overcome production failures, that last longer, and serve the industry more smoothly . . . . these have an important place in the countless variety of Certified Steels carried in Ryerson warehouse stocks. They help to make Ryerson the ideal source of steel supply for the Chemical Industry.

Special steels and alloys particularly important to chemical manufacturing are carefully selected to meet an ideal specification that assures uniform heat-treating response. Complete data sheets covering chemical and physical analysis, grain size, cleanliness rating and hardening characteristics accompany every shipment of Ryerson Certified Alloy Steel.

99 years of serving industry with steel has enabled Ryerson to maintain stocks in the face of unprecedented demand. Service is prompt and reliable. Whatever your steel requirement, no matter how unusual or exacting, phone, wire or write your nearest Ryerson plant! Make Ryerson your dependable source for steel!

PRODUCTS INCLUDE

Allegheny Stainless	Structurals
Alloy Steels	Hot Rolled Bars
Tool Steels	Sheets (over 25 kinds)
Cold Finished Bars	Plates (over 15 kinds)
Shafting	Welding Rod
Tubing	Solder, Babbitt
Boiler Tubes	Nuts, Bolts, etc.

Write for Stock List

Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON *Certified* STEELS

RYERSON CERTIFIED STEELS

PERSONALITIES

Henry G. Knight

L. M. Rice

✦ HENRY G. KNIGHT, chief of the Bureau of Agricultural Chemistry and Engineering will be awarded the medal of the Institute of Chemists. The award is made in recognition of Dr. Knight's outstanding accomplishments in the field of agricultural chemistry and his executive and creative ability as administrator of the four regional research laboratories recently established by Congress.

✦ ALEXANDER SILVERMAN, head of the department of chemistry at the University of Pittsburgh, received the 1940 Pittsburgh Award of the local section of the American Chemical Society on March 20. The award was made for outstanding service to the profession of chemical education and for distinguished contribution to industrial chemistry and the ceramic industry. Dr. Silverman whose work is recognized internationally was born in Pittsburgh on May 2, 1881 and was graduated from the Western University of Pennsylvania, now the University of Pittsburgh, in 1902. He received his A.B. degree from Cornell University in 1905 and M.S. from Pittsburgh in 1907. He joined the Pittsburgh faculty in 1905 and became head of the department of chemistry in 1918.

✦ CLAUDE S. HUDSON of the National Institute of Health, U. S. Public Health Service, Washington, D. C., has been chosen second recipient of the Borden Co. Award in chemistry of milk. The award was given him during the St. Louis meeting of the American Chemical Society.

✦ E. V. COLLINS is now with the Chromium Corp. of America. He is in the research and development department.

✦ L. M. RICE has been appointed assistant sales manager of the organic chemicals department, American Cyanamid & Chemicals Corp. He is a graduate of both Hamilton College and the Massachusetts Institute of Technology. After graduating from college he entered the Cyanamid organization as a member of the newly created insecticide department which was then just getting under way.

✦ HARRY V. CHASE is manager of the Radford (Va.) Ordnance Works which were constructed under the direction of the Hercules Powder Co. and will be operated by that organization. This powder plant commenced operations a short time ago. Phil F. Powelson is construction superintendent at the plant.

✦ L. C. WILSON, general manager of the Reading-Pratt & Cady Division and the Reading Steel Casting Division of American Chain & Cable Co., has been awarded the Lorenz medal by the Steel Founders Society of America.

✦ DAVID W. CARNELL, chemical engineering senior at Tufts College, has been awarded a Tau Beta Pi fellowship for graduate study in engineering. He will do his advanced work at Massachusetts Institute of Technology. The fellowship, one of eight awarded annually, by the association, is based on scholastic qualifications, objective in study and ultimate goal.

✦ GEORGE B. BEITZEL, manager of sales of Pennsylvania Salt Mfg. Co. has been elected president of the Sales Managers Association of Philadelphia. He will assume his new duties at the Fall meeting of the Association.

✦ DAVID RITTENBERG of the Columbia University School of Medicine was given the sixth Eli Lilly & Co. Award in biological chemistry for his work on isotopes as tracers in chemical reactions. This award also was made during the Spring meeting of the American Chemical Society.

✦ W. W. TOMES has been appointed to head the flow meter section of the Cochrane Corp., Philadelphia. Mr. Tomes graduated from Purdue University in 1928 and has been associated with the Firestone Tire & Rubber Co. in flow measurement and steam distribution work, and more recently in meter field engineering and sales work. Assisting Mr. Tomes will be W. C. Morrison, recently associated with the Brooklyn Union Gas Co. as sales engineer. Mr. Morrison attended the University of North Carolina and graduated from Brooklyn Polytechnic Institute in 1936.

✦ CARLTON B. SMITH, formerly district service engineer of Allis-Chalmers Mfg. Co. in the southeast district, has been promoted to district superintendent of service and erection with headquarters at Atlanta.

✦ R. E. SCOTT, formerly chief chemist of the Marlin-Rockwell Corp., Jamestown, N. Y., has been added to the Quaker Chemical Products Co.'s technical sales force in the Northern Ohio territory. He will make his headquarters at Berea, Ohio. He has had extensive experience in the application of cutting oils, grinding compounds, rust preventives and both the alkaline and solvent type cleansers used in metal processing.

✦ M. BAKST, formerly working on production and design for Vinci Fencing Equipment, Inc., is now associated with the Federal Telegraph Co., Newark, N. J., as chemical engineer.

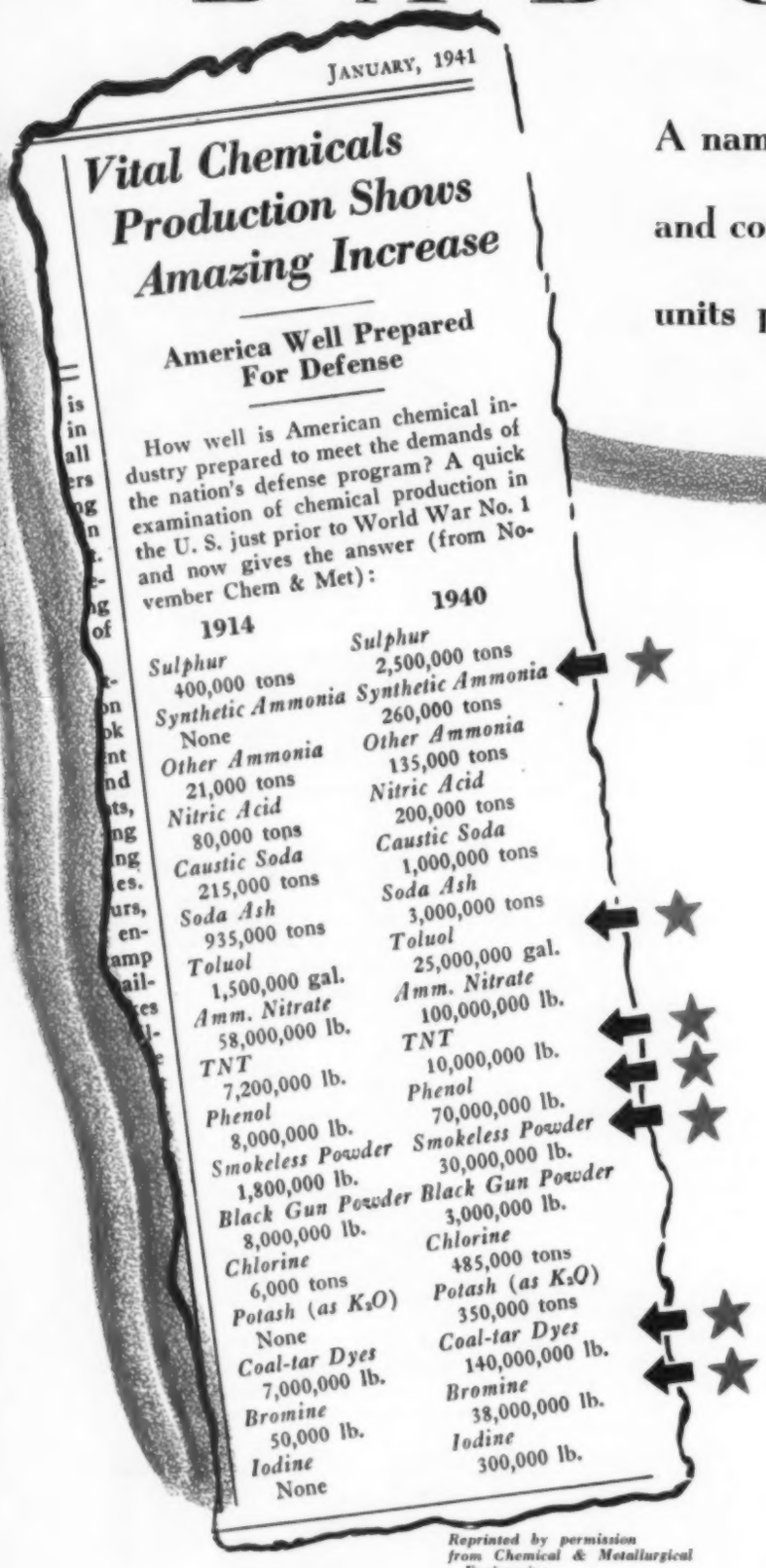
✦ HAROLD B. ROY has left his personal interests at Sudbury, Ont., to join the Defense Industries, Ltd., in the manufacture of explosives.

✦ FRANCIS E. FINCH, formerly president of Ruggles-Coles Engineering Co. and later vice president of Hardinge Co., is now associated with Centrifugal & Mechanical Industries, Inc.

✦ F. J. STOKES, JR., is now treasurer and coordinator of engineering production for F. J. Stokes Machine Co.,

BADGER

A name long identified with the design and construction of complete plants and units producing many of our essential chemicals



JANUARY, 1941

Vital Chemicals Production Shows Amazing Increase

America Well Prepared For Defense

How well is American chemical industry prepared to meet the demands of the nation's defense program? A quick examination of chemical production in the U. S. just prior to World War No. 1 and now gives the answer (from November Chem & Met):

1914	1940
Sulphur 400,000 tons	*Sulphur* 2,500,000 tons
Synthetic Ammonia None	*Synthetic Ammonia* 260,000 tons
Other Ammonia 21,000 tons	*Other Ammonia* 135,000 tons
Nitric Acid 80,000 tons	*Nitric Acid* 200,000 tons
Caustic Soda 215,000 tons	*Caustic Soda* 1,000,000 tons
Soda Ash 935,000 tons	*Soda Ash* 3,000,000 tons
Toluol 1,500,000 gal.	*Toluol* 25,000,000 gal.
Amm. Nitrate 58,000,000 lb.	*Amm. Nitrate* 100,000,000 lb.
TNT 7,200,000 lb.	*TNT* 10,000,000 lb.
Phenol 8,000,000 lb.	*Phenol* 70,000,000 lb.
Smokeless Powder 1,800,000 lb.	*Smokeless Powder* 30,000,000 lb.
Black Gun Powder 8,000,000 lb.	*Black Gun Powder* 3,000,000 lb.
Chlorine 6,000 tons	*Chlorine* 485,000 tons
Potash (as K_2O) None	*Potash (as K_2O)* 350,000 tons
Coal-tar Dyes 7,000,000 lb.	*Coal-tar Dyes* 140,000,000 lb.
Bromine 50,000 lb.	*Bromine* 38,000,000 lb.
Iodine None	*Iodine* 300,000 lb.

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ONE CONTRACT UNDIVIDED RESPONSIBILITY

Badger Units and Complete Plants have played an important part not only in the tonnage of chemicals produced in the year 1914, but in the startling increase in tonnage since then.

All of Which Implies extensive experience in plant design for the production of chemicals. Coupled with this is experience gained by work in other divisions of the processing industry.

Badger Services are available to any extent—economic studies, research, design, process, equipment for part of plant or a complete plant operating to meet guarantees.

★

1841-1941

One Hundred Years of Service

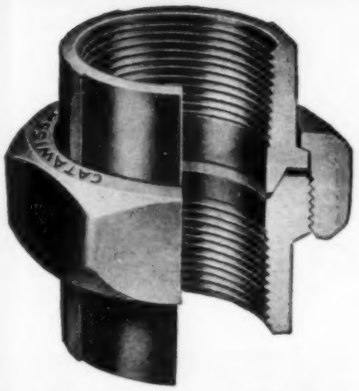
★

E. B. BADGER & SONS CO.

Boston, Mass.

New York Philadelphia San Francisco London Paris

CATAWISSA



STANDARD UNIONS
Hot Forged From Solid Steel Bars

The forging process further refines the steel in Catawissa Unions and enables them to withstand years of shock and vibration. Seats, Steel to Steel, STAINLESS STEEL to Steel or Bronze to Steel are carefully hand ground, require no packing and are set on a 55° angle with a flat surface contacting a ball surface. This insures a perfect seal even though pipe is out of line . . . . Write for complete data and prices.

THE CENTRAL FORGING CO.
CATAWISSA, PENNA.

N. B.

• The opposite advertisement of E. B. BADGER & SONS CO. is a corrected repeat of the advertisement appearing on page 110 of the March issue of *Chemical & Metallurgical Engineering* in which a printer's error located the arrows opposite the wrong products giving an incorrect picture of this company's activities.

— *The Publishers*

Philadelphia. For several years Mr. Stokes has been actively engaged in engineering, especially in development of high vacuum equipment.

✦W. D. HARRISON, formerly of the Riegel Paper Corp., is now with the Ecusta Paper Co., Pisgah Forest, N. C.

✦HOWARD A. SMITH, formerly of the Duraloy Co., is now associated with Universal-Cyclops Steel Corp., Bridgeville, Pa. as research metallurgist.

✦GEORGE S. NICHOLS has a position in the R. & H. Chemicals Division, E. I. duPont de Nemours & Co., Niagara Falls, N. Y. Mr. Nichols recently graduated from the University of Wisconsin.

✦FRED W. AHRENS is working in the Organic Chemicals Department of E. I. duPont de Nemours & Co., Wilmington, Del.

✦ERNEST R. HUFF on February 4 was ordered to active duty at Aberdeen Proving Ground, Md. Captain Huff's assignment is proof officer in mobile artillery. The work involves ballistic acceptance tests of ammunition and components for guns and howitzers.

✦J. L. BALLARD, formerly with City Packing Co. of Fort Worth, Tex., where he served as chief chemist, is now in the same capacity with the Fearn Laboratories of Chicago.

✦C. L. AGRE, in November, was ordered from his position as research chemist at the Experimental Station of E. I. duPont de Nemours & Co., to report for active duty with the 21st Coast Artillery at Fort du Pont, Del. Lieutenant Agre had been in the Officers' Reserve Corps.

✦ROBERT V. WILLIAMSON is head of Plastics and Building Materials Section of the Agricultural Residues Devision of the Northern Regional Research Laboratory. His work consists of superintending research on the utilization of farm or agricultural residues such as straw, cornstalks, etc., in plastics and building materials.

✦DAVID J. EDDLEMAN, formerly with H. B. Egan Mfg. Co., Muskogee, Okla., is now junior chemist with Stanolind Oil & Gas Co. near Vivian, La.

✦HENRY B. LINFORD has been appointed instructor in chemical engineering at Columbia University, succeeding Dr. R. R. Rogers who is now in the employ of the Canadian government.

✦ARTHUR BURNS, JR., formerly with the Pacific Alkali Co., is now employed in the paint laboratory of the U. S. Navy Yard, Mare Island, Calif.

MONARCH
CORROSION RESISTANT NOZZLES
Of

Fig. F-80

STAINLESS STEEL:
Available in capacities from .0095 G.P.M. (Fig. F-80 style illustrated) to 104 G.P.M. (Fig. B-8-A style).

"Hollow" cone, "Solid" cone, and "Flat" sprays furnished in pipe sizes and capacities to suit practically any problem where corrosive liquids are sprayed.

STONEWARE:
Monarch Fig. 6020 and Fig. 6040 stoneware sprays have replaced most other types of nozzles used in acid chamber plants throughout the world. Last almost indefinitely in sulfur gases and will not break or crack from temperature changes.

HARD RUBBER
Patented Fig. B-27 nozzle is of the "non-clog" type; i.e. it contains no internal vanes, slots, or deflectors which might facilitate clogging. Available ¼" to 1" pipe. Small sizes produce a very fine, soft, wide angle hollow cone spray, even at low pressures.

Fig. H-407 "flat" spray produces a relatively fine even sheet of liquid.

Write for Catalogs 6A and 6C

MONARCH MFG. WKS, INC.
2730 E. WESTMORELAND ST.
PHILADELPHIA, PA.

Protect your production schedules, Lower maintenance costs through corrosion resistant valves and fittings

ALOYCO STAINLESS STEEL VALVES — FITTINGS

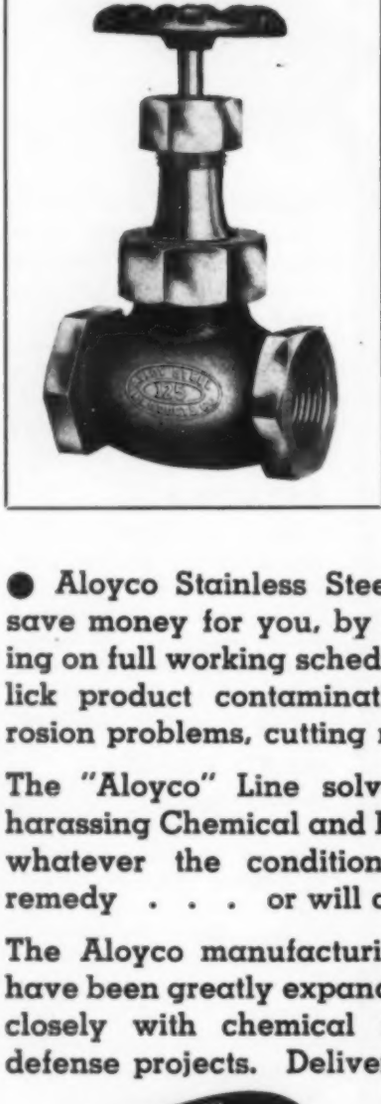


Figure No. 40

GLOBE VALVE

Construction Data

Made in Globe and Angle types, sizes ¼" to 2". Union Bonnet type. Screwed ends only, for 125# W.P.

Metal to metal tapered seats, and seats are integral with bodies. Valves may be repacked under pressure when wide open.

Small sizes made completely of bar stock with screwed in bonnets. All parts of alloy with exception of hand-wheel and nut.

Carried in stock in Chrome Nickel 18-8 S.

● Aloyco Stainless Steel Valves and Fittings will save money for you, by keeping your plant operating on full working schedule and eliminating hard-to-lick product contamination, solving stubborn corrosion problems, cutting maintenance costs.

The "Aloyco" Line solves most serious problems, harassing Chemical and Process Manufacturers. For, whatever the condition, Aloyco either has the remedy . . . or will create help by its engineers.

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✦ WILLIAM SHELDON ARNOLD, has recently accepted a position with the Wood Conversion Co., Cloquet, Minn. He is employed in the development department of this company.

✦ R. E. GLADSTONE, previously connected with Condor Solvents, Inc., Lyndhurst, N. J., is now working as plant chemist for Commonwealth Plastic Co., Leominster, Mass.

✦ P. E. GERHARD is sales engineer for the American Steel Casting Co., Newark, N. J.

E. R. Woodward

✦ E. R. WOODWARD of the British Purchasing Commission is joining Mathieson Alkali Works. Captain Woodward, a former Barrett Co. engineer, is a graduate of McGill University.

✦ H. L. HARDY, who received his degree in chemical engineering from Texas Technological College at Lubbock, Tex., in June 1940, is with Warren Petroleum Corp. When he first joined the corporation he was located at the company's plant at Monument, New Mex., as assistant laboratory technician, but has since been transferred to the Galva, Kans., plant where he is in charge of the laboratory.

✦ B. B. BROOKS joined the Phillips Petroleum Co. in 1939 in the Oklahoma City district. After having served in several of the company's plants, he has been transferred to the Borger, Tex., refinery where he is assigned to the new butadiene laboratory.

✦ PAUL E. TRADER after receiving preliminary training at the Repauno plant of the E. I. duPont de Nemours & Co. is now at the Barksdale plant of the company.

✦ CECIL H. CHILTON, formerly in the research and development division of the Socony-Vacuum Oil Co. at Paulsboro, N. J., is now connected with E. I.

du Pont de Nemours & Co., Wilmington, Del. Mr. Chilton is in the design division of the engineering department.

✦ DONALD WROUGHTON, who was employed temporarily by Procter & Gamble in its plant at Cincinnati, has now returned to Columbia University in order to complete work he has been carrying on there for several years.

✦ JAMES DONAT was formerly with the Girdler Corp. of Louisville, Ky. He has now joined the Blaw-Knox Co. and is piping engineer on high pressure power plant piping in the power piping division.

✦ WARREN K. EISTER, who has been in the shop engineering department of the American Car & Foundry Co. at Milton, Pa., is now a chemist in training at the E. I. du Pont de Nemours & Co. smokeless powder plant, Carney's Point, N. J. He is slated to go to the smokeless powder plant being constructed at Charlestown, Ind.

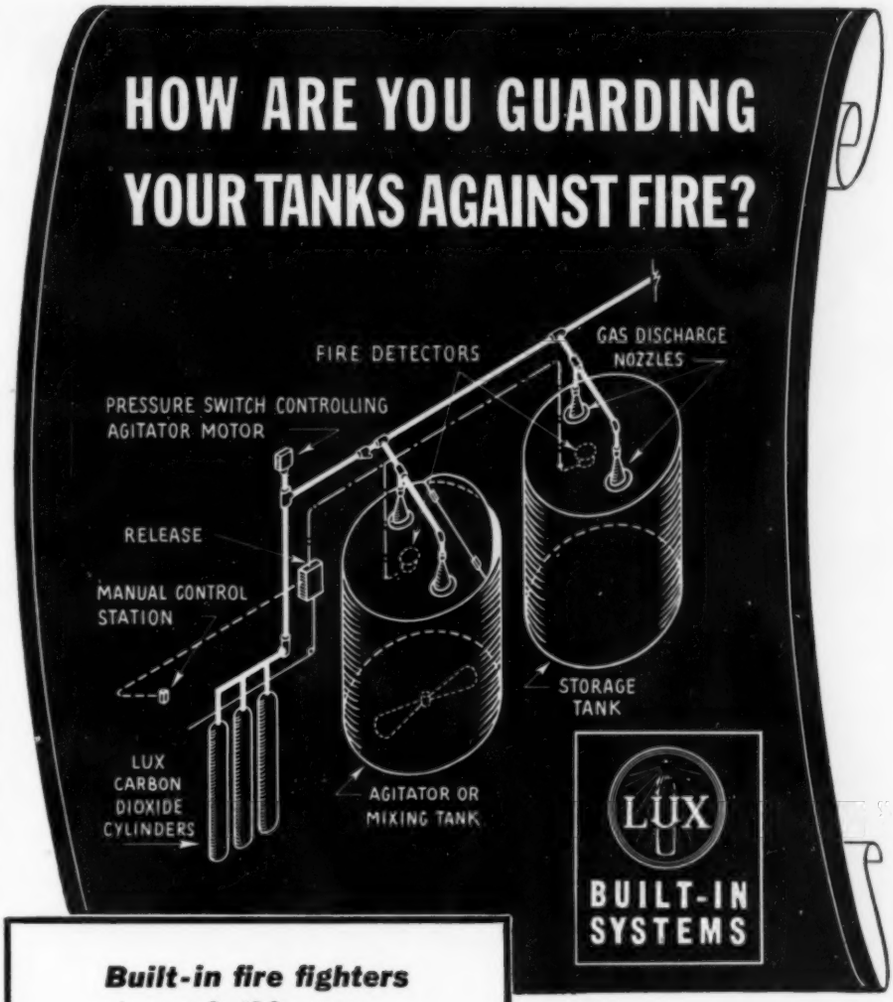
✦ RALPH NAFFZIGER, who was formerly associated with the Carteret, N. J., division of Westvaco Chlorine Products Co. as department head and supervisor, at the present time is a civilian Chemical Warfare Service inspector in the Chicago district. Mr. Naffziger is assigned to inspection duty at the General Tire & Rubber Co. of Wabash, Ind.

W. L. Badger

✦ W. L. BADGER was recently made a director of Whiting Corp., Harvey, Ill. Mr. Badger, formerly on the staff of the University of Michigan, has been associated with the Swenson Evaporator Co. for many years.

✦ JOHN H. WILKINS, who was formerly superintendent at the H. V. Walker Co.'s Elizabeth, N. J., plant producing lacquers and enamel finishes, is now employed as metallurgist with the Eclipse Aviation Corp., division of Bendix Aviation Corp. at Bendix, N. J.

✦ PAUL F. FLAMM is a chemical engineer in the Tennessee Eastman Corp.,



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Kingsport, Tenn. Mr. Flamm is in the department of manufacturing experiments, where he is doing research work on rayon fibers and Tenite plastics.

✦ DONALD V. ROSS has transferred his activities from the Eastman Kodak Co. at Rochester to the Tennessee Eastman Corp., where he is employed in the department of manufacturing experiments, working on the development of cellulose ester plastics.

✦ B. C. BARTLETT has resigned his position as ceramic engineer with the O'Keefe & Merrit Co. and is now associated with Mueller Brass Co. at Port Huron, Mich.

✦ GEORGE W. FORMAN, who was employed in the plating department of Seth Thomas Clock Co., Thomaston, Conn., is now in the metallurgical laboratory of the Harrison, N. J., works of Crucible Steel Co. of America.

✦ SYLVESTER T. SCHICKTANZ is taking charge of the motor fuels research division of the Northern Regional Laboratory of the Bureau of Agricultural Chemistry and Engineering at Peoria, Ill. Mr. Schicktanz was formerly with the National Bureau of Standards and more recently with the alcohol tax unit of the Bureau of Internal Revenue. The division which he directs will investigate technical methods and economic possibilities of alcohol for motor fuel and do research on other products of fermentation which may be considered as possible components of internal combustion engine fuels.

✦ F. E. LAWRENCE is acting director and consultant for the South Carolina State Planning Board and also is industrial consultant to the Charleston Industrial Bureau.

✦ FRANK E. PAVLIS, after a year and a half of research and experimental work on small air liquefaction oxygen plants, is now associated with Air Products, Inc. as chief engineer.

✦ DANIEL B. CURLL, JR., research director of Rumford Chemical Works, was elected a director of the company at the annual meeting late in February.

✦ DONALD J. REESE will be awarded the J. H. Whiting Gold Medal of the American Foundrymen's Association. He recently accepted his present position of foundry research engineer, Research & Development Division, International Nickel Co., New York, N. Y. Mr. Reese graduated from the chemical engineering department of the University of Michigan and for some years was employed by the Whiting Corp.

✦ JAMES T. COSTIGAN has terminated his connection with the Sharples Corp.'s export company the International Centrifugal Sales, Ltd., and is now acting as New York District manager of the Sharples Corp.

✦ EDWARD B. MORROW, assistant treasurer of Hercules Powder Co., was elected treasurer and a member of the executive committee on March 26.

✦ JACQUES ERRERA, Belgian chemist and formerly professor of physical chemistry at the University of Brussels, has been appointed manager of the Research and Control Division of Sidney Blumenthal & Co.

✦ R. M. PLACE has been added to the staff of chemists at the Chicago laboratory of D. W. Haering & Co. He will assist in the recently expanded research program.

✦ L. M. LINDSEY has joined the General Alloys Co., Boston. Previously he had been with Surface Combustion Corp. for six years.

✦ ROBERT L. CLAUSE, who joined the Pittsburgh Plate Glass Co. in 1914, has been elected president. He succeeds H. S. Wherrett, who becomes vice chairman of the board of directors.

✦ IVOR GRIFFITH, dean of pharmacy at the Philadelphia College of Pharmacy and Science, has been elected president of the institution.

✦ IRVING H. TAYLOR has been elected vice president in charge of sales of the Michigan Alkali Co.

OBITUARY

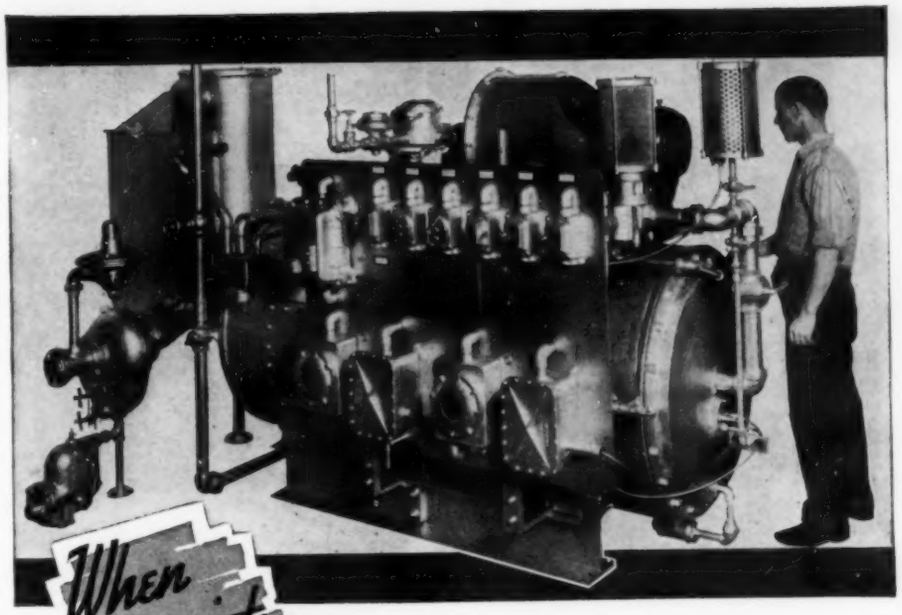
✦ JAMES R. BAILEY, professor of organic chemistry at the University of Texas, died March 25 of a paralytic stroke. He was 72 years old. His services with the university covered a period of nearly 50 years.

✦ WILLIAM I. SIVITZ, manager of the Pittsburgh office of the Duriron Co., Dayton, Ohio, died suddenly January 30 in Pittsburgh. Mr. Sivitz was the newly elected president of the Pittsburgh chapter of the A.I.Ch.E. and was a graduate of the Carnegie Institute of Technology.

✦ GEORGE E. WHITE, for many years manager of Pacific Alkali Co., died March 22. He was 55 years of age. Mr. White passed away at his home in San Marino, Calif., of a heart attack. He was a native of Nebraska and went to Los Angeles in 1899, and graduated from the University of California at Berkeley in 1908.

✦ LOUIS A. KAHLENBERG died March 18 at Sarasota, Fla., where he was residing. Dr. Kahlenberg retired from the faculty of the University of Wisconsin several years ago. He was 71 years old.

✦ HUGO O. WENTWORTH, 61 years old, founder and president of the Vulcan Copper & Supply Co., died in Christ Hospital in Chicago as the result of a cerebral hemorrhage March 14.



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Electrochemists Hold Convention

Chem & Met MEETINGS & CONVENTIONS

ELECTROCHEMICAL and related problems of major importance were discussed April 16-19 in a total of 25 papers at the 79th meeting of the Electrochemical Society in Cleveland. Prof. F. C. Mathers of the University of Indiana delivered his presidential address on Thursday evening, with Adventures in Electroplating as the topic. The same evening the $1,000 Weston Fellowship was awarded to the most deserving young student and the Authors Prize for the best electrochemical paper published during 1940. In the following paragraphs are abstracted a few of the papers presented.

Sodium Chlorate Cell—In connection with engineering work previously conducted, a laboratory study was made by the U. S. Dept. of Agriculture of conditions necessary for the efficient operation of a sodium chlorate cell with graphite anodes. This study led to the development of the rod cathode cell described by James McLaren, Jack Turer, A. L. Pitman, P. H. Groggins, all of the U. S. Department of Agriculture and F. H. Davis of the U. S. Geological Survey. The study gave special consideration to anode life, temperature of operation, electrolyte acidity, anode and cathode efficiency, current concentration, current density, voltage, and cell design.

The rod cathode cell, especially suitable for use with off-peak power, was found to operate at 25 deg. C. with such a low rate of graphite attack that the test period of 4 months covered only a small fraction of the total anode life. Even with an allowance of 100 percent for the greater rate of attack in old anodes, the graphite attack would be 6-10 lb. of graphite per ton of sodium chlorate, an amount less than 50 percent of that previously reported. Graphite anodes with an apparent density of about 1.80 had 15-20 percent longer life than anodes with an apparent density of 1.70, which had in turn 30-40 percent longer life than those with density of 1.60.

Voltage drop in the rod cathode type cell was only 0.3 volt as compared to 3 volts for the older type at an anode current density of 0.08 amp. per sq. cm. The rod type of construction was designed not only to give low voltage drop in the electrolyte with new anodes, but also to permit the spacing between cathode and anode to be taken up in such a way that the anode is worn down to a small diameter uniform throughout its length. The combination of principles applied in construction of rod cathode electrode units improved the current efficiency and decreased the graphite attack, the HCl loss, and the voltage. These units operated successfully in a variety of cell tanks.

Anodic Coatings on Aluminum—The rapidly increasing use of anodic coatings on aluminum alloys has stimulated interest in their properties and the manner of their formation. Coatings of this type are formed when the aluminum is anode in an electrolyte such as a dilute solution of sulphuric, oxalic, chromic or boric acid and the treatment continued until the oxide coating reaches the desired thickness or the current flow ceases.

Although formed in aqueous solutions, anodic coatings are apparently comprised of oxide and not hydrates or hydroxides, reported J. D. Edwards and Fred Keller of the Aluminum Research Laboratories, New Kensington, Pa. As to reactions at the anode, there seems to be no necessity for assuming other than a direct oxidation to Al_2O_3 by nascent oxygen. Whereas the growth of coating in an electrolyte such as boric acid stops when a definite thickness is reached, coatings made in sulphuric, oxalic, or chromic acid continue to grow as long as electric potential is applied. Contrary to the impervious type of film, the films formed in an electrolyte in which the oxide is appreciably soluble are porous in nature.

Data presented justified the conclusion that the aluminum is oxidized in electrochemical equivalent to the amount of current. The fact that apparent current efficiency in terms of aluminum removed was usually greater than 100 percent suggests that some metal dissolved, a fact supported by gas liberation at the anode. The coating accounted for only 60-80 percent of the aluminum lost; thus 20-40 percent evidently dissolved in the electrolyte. The table below shows the relation between weight of anodic coating and aluminum removed in 15 percent H_2SO_4 electrolyte with c.d. of 12 amp. per sq.ft. at a temperature of 25 deg. C., using 99.8 percent foil:

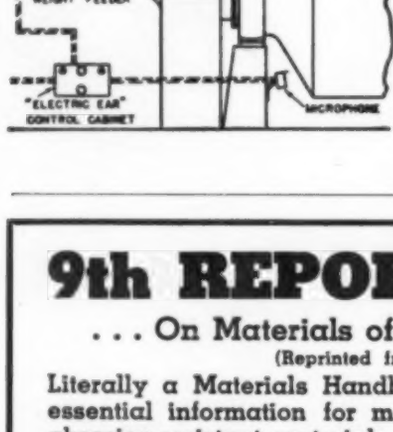
Oxidation Time — Min.	Al_2O_3 Coat Oz./100 sq.ft.	Apparent Cur. Efficiency	Al Metal Remov. Oz./100 sq.ft.	Apparent Cur. Efficiency
2	0.710	79.4%	0.487	103.0%
4	1.411	78.9	0.977	103.2
6	2.079	77.5	1.438	103.3
8	2.798	78.2	1.948	102.9
10	3.492	78.1	2.444	103.3
15	5.158	76.9	3.649	102.8
20	6.689	74.8	4.813	101.7
30	9.511	70.9	7.155	100.8
60	17.12	63.8	14.37	101.2

X-ray diffraction of coatings made in sulphuric acid electrolyte by the Alumilite process (U. S. Patents 1,526,127; 1,869,058; 1,900,472; 1,946,147; 1,946,152, owned by Aluminum Company of America) gave no evidence of crystalline structure. After formation, it is possible to convert the coating into monohydrate by treatment with boiling water. This is the sealing procedure of the Alumilite process which closes the pores effectively and thus destroys the adsorptive characteristics of the coating.

Improved Storage Batteries—Antimony constitutes 5-15 percent of storage battery grids primarily because antimonial lead can be cast more readily, is stiffer, has higher tensile strength and a lower coefficient of

CALENDAR

APRIL 24-25,	National Petroleum Association, semi-annual meeting, Hotel Cleveland, Cleveland, Ohio.
MAY 19-21,	American Institute of Chemical Engineers, semi-annual meeting, Edgewater Beach Hotel, Chicago, Ill.
MAY 19-23,	American Petroleum Institute, mid-year meeting, Fort Worth, Texas.
JUNE 16-20,	American Society of Mechanical Engineers, semi-annual meeting, Kansas City, Mo.
JUNE 23-27,	American Society for Testing Materials, annual meeting and exhibit, Palmer House, Chicago, Ill.



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expansion than pure lead. No other lead alloy has been used commercially in storage batteries to any extent for over 50 years although antimonial lead has recognized disadvantages, such as excessive sulfation of negative plates and higher resistivity than pure lead. Experimental work to overcome disadvantages of antimonial lead in storage battery grids by addition of 0.05-0.15 percent silver was reported upon by Colin G. Fink, Columbia University, and Albert J. Dornblatt, Crown Cork and Seal Company, Baltimore. No previous study of the effect of silver in battery grid metal has been published, although interesting properties of lead anodes containing silver have been known.

Addition of 0.05-0.15 percent silver to 4-12 percent antimony-lead alloys inhibited anodic corrosion, lowered the amount of antimony dissolved from the anode and deposited on the cathode, and lowered the tendency of the battery to overheat on overcharge. Chill-cast grid alloys with 4-8 percent antimony can be heat-treated with improvement in strength and some improvement in conductivity. Addition of 0.05-0.10 percent silver increased the maximum strength about 20 percent. Grid alloys containing 4-12 percent antimony showed that the average life of the batteries was prolonged about 4 percent when 0.05-0.15 percent silver was present in the metal. Results of certain tests are summarized in the accompanying table.

Percent Nom. Composition		Percent Alloy Loss by Anodic Corrosion		Percent Battery Life Increase
Sb.	Ag	Strength	Thickness	
12	....	34.4	13.8	...
	0.05	19.0	4.6	3.8
	0.10	7.4	1.5	3.0
	0.15	2.5	0.0	3.0
8	....	26.4	13.8	...
	0.05	13.0	4.6	4.9
	0.10	0.0	3.1	...
	0.15	2.7	0.0	9.3
6	....	22.4	9.2	...
	0.05	9.7	3.8	2.6
	0.10	2.8	2.0	6.2
	0.15	2.9	0.0	3.6
4	....	23.3	8.9	...
	0.05	8.6	4.6	3.0
	0.10	1.7	2.0	7.3
	0.15	0.0	0.0	6.4

In connection with the improvements in the conventional storage battery, the authors stated that increase in battery cost should be slight, and in the case of heat-treated alloy, the cost may even be reduced as a consequence of replacing 4-8 percent antimony by 0.10 percent silver. In addition, about 4,000 tons of antimony per year should be released for more strategic uses and almost 100 tons of silver, of which there is a huge surplus, should be absorbed by the new market.

Indium Plating—The price of indium has been recently reduced from $28 per oz. avoirdupois for 97 percent metal and $70 per oz. for 99.9 percent metal to about $15 per oz. for 99 percent metal. This recent active interest in indium and its industrial uses stimulated an investigation, reported upon

by Henry B. Linford, American Smelting and Refining Co., Barber, N. J., to develop optimum conditions for indium plating.

Satisfactory indium plates can be obtained from indium sulphate baths at room temperature by maintaining the pH within a range of 2.0-2.7, reported the author. A practical way to maintain this pH for an indefinite period of time is by use of soluble and insoluble electrodes. Baths containing 20 g. indium per liter were recommended, since more dilute solutions are subject to rapid pH changes and the advantages of more concentrated solutions do not warrant their increased cost. Such solutions with 10 g. per liter of Na_2SO_4 at room temperature gave a satisfactory, smooth matte deposit about 0.0001 in. thick on base metals such as mild steel, wire bar copper, silver 999 fine, refined lead, and lead and cadmium base bearing alloys. No bath failed to function even after service over a period of many months.

To prepare an indium sulphate solution, metallic indium is rolled into a thin ribbon and dissolved in dilute H_2SO_4. A small excess of indium should be used and the solution held near the boiling point in order to reduce the acid content. A pH of 1.5-2.0 can be easily obtained. The proper amount of Na_2SO_4 is then added and the electrolyte is ready for use. The plating cell should be equipped to circulate the electrolyte fairly rapidly; for a 10 liter cell a circulation of about 200-400 ml. per min. proved satisfactory. A typical example was given of conditions in the indium plating bath.

Metallic Resistor Furnaces—According to W. Kroll of Niagara Falls, N. Y., high temperature metallic resistor furnaces have generally been of small size and, with the exception of the tungsten lamp factories, their use has been limited to the laboratory. With the development of various materials requiring high temperature treatment, there has been an increasing demand for furnaces suitable for commercial plant use. Ordinary metallic resistors such as nickel-chrome alloys or iron-chrome-aluminum alloys are limited for use in resistor furnaces. The upper temperature limit of these alloys is 1,000 deg. and 1,200 deg. C. respectively for a life of about 1,000 hrs. However, for temperatures above 1,200 deg. C., molybdenum or tungsten resistors operating under a gas seal or in a vacuum are suitable, and have been in commercial operation in tungsten lamp factories for many years. Tantalum as a resistor metal is not applicable. Aside from its high price, it is sensitive to gases and is quickly embrittled at high temperatures by hydrogen, nitrogen, or traces of oxygen. Furthermore, tantalum reacts with most of the known ceramic materials now in use.

New metallic resistor furnaces, using molybdenum or tungsten, which can be operated continuously in plant practice were described by the author. Molybdenum melts at about 2,620 deg. C. and tungsten at about 3,390 deg. C. At 2,000 deg. C. molybdenum is so soft that it is difficult to make it hold shape while tungsten, containing a trace of oxygen, remains rigid up to 2,500 deg. C. In addition, the evaporation of molybdenum is appreciable at 2,000 deg. C. Thus, tungsten is preferred for use above this temperature, especially if contamination of the article is to be avoided. Moist hydrogen favors evaporation of both metals (lamp blackening). Another important factor is the shape and support of the resistor. The author's final design consisted of a multistrand tungsten wire helix suspended freely.

No reduction action was noted on Al_2O_3 refractory material at about 2,000 deg. C. nor any on ZrO_2 at 2,300 deg. C. However, Al_2O_3 is suitable for use only below 1,800 deg. C. and La_2O_3 is unstable in hydrogen above 2,000 deg. C. One of the best refractory materials was found to be BeO, since it is easy to mold and is passive toward heating units of molybdenum or tungsten although it vaporizes readily near its melting point of 2,550 deg. C. Alundum may be used successfully up to about 1,700 deg. C.

Furnace atmosphere requires careful consideration. Hydrogen is by far the most suitable gas, but cracked ammonia is more readily available and is safer to use. Moist hydrogen and cracked ammonia give rise to enormous grain growth in the resistor and cause burn-out. The author also described proper heat insulation, performance, and other factors in the new design tungsten high-temperature resistor furnaces.

Cyanide Plating Baths—The properties of cyanide plating baths, used for the plating of all gold, silver, cadmium and brass as well as for much of the plating of copper and zinc, were described by M. R. Thompson of the National Bureau of Standards. These baths are characterized by smooth and fine-grained deposits, good anode corrosion and high throwing power, and are useful for deposition of alloys.

Cyanide plating baths of heavy metals give complex coordination compounds. Metals forming cyanide anions with low coordination numbers tend to deposit most readily. Addition of alkali cyanide causes a shift toward a higher coordination number, resulting in lower cathode efficiency and higher cathode polarization. If a metal does not deposit readily from a complex cyanide anion, addition of a less stable anion may promote deposition from the "mixed bath" and also prevent precipitation of metallic compounds. Although chemical control of the bath is more difficult, the practice is of importance in depositing some alloys, such as the use of zincate in a zinc bath and of glucosate or tartrate in an indium bath. A metal that is not deposited alone can often be codeposited as an alloy with a metal

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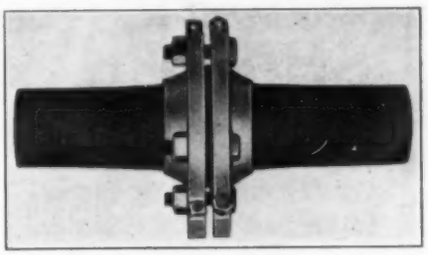

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that is easily deposited. Examples are the deposition of nickel with copper or gold and of zinc with copper.

In reviewing the properties of the copper cyanide bath, the author stated that excess alkali cyanide has a marked effect in lowering cathode efficiency and raising cathode polarization. Elevation of temperature has an opposite effect, at least when alkali cyanide is not too high. Deposition at about 100 percent efficiency is possible within a narrow range of conditions. High metal content, low cyanide ratio, and temperature of 40-80 deg. C. are desirable. It is now common practice to control the pH, as this factor influences appearance and structure of the deposit. The use of large amounts of Rochelle salt is based upon the principle of the mixed bath. The tartrate increases anode efficiency and decreases anode polarization, thus permitting use of higher current densities, particularly at a high pH. Apparently the tartrate reduces or dissolves cupric compounds which tend to coat the copper anode at a high current density or a high pH. The author also discussed general properties of a large number of other cyanide plating baths.

Electrodeposited Copper—Structure and grain size of electrodeposited copper from acid copper sulphate solutions was reported upon by Allison Butts, Lehigh University, and Vittorio De Nora, University of Milan, Italy. Graphs were given showing the relation between (1) cathode potential and current density at three different acidities and three different temperatures; (2) grain size and current density at two acidities and three temperatures; (3) grain size and temperature at different current densities and acidities; (4) grain size and cathode potential at different current densities, temperatures, and acidities; and (5) grain size and hardness for different temperatures of deposition. The relation between grain size and acidity was studied for acidities of 18.5 and 50 g. of H_2SO_4 per liter. The study was inspired by the importance of grain size on character of deposits, recent advances in grain-size control, and introduction of grain-size specifications for certain steel and other metals.

Rise of temperature in the electrolyte was found to increase the grain size of the deposit as velocity of crystal growth is increased more than that of nucleus formation. Deposits obtained at high temperatures were more uniform in regard to size of grains. The effect of acidity in general was small up to 50 g. of H_2SO_4 per liter, but the direction of its effect was different under different conditions, and temperature rise may alter the effect of change in acidity. Graphs were also shown to demonstrate that grain size became smaller as the cathode potential became less noble.

Results showed quantitatively that grain size became progressively smaller as current density increased. At low current density the deposit is coarse-

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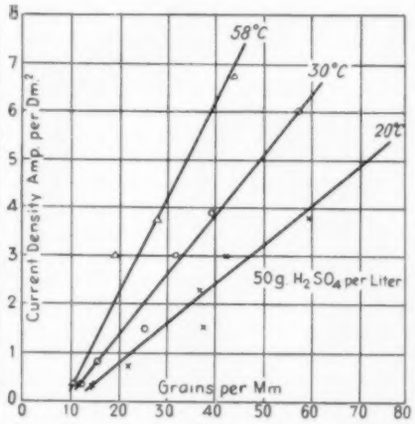
grained because crystal grains from slow deposition are larger than those from rapid deposition. By increasing current density the deposit becomes finer, but with further increase the crystal grains are no longer regular, a broken structure is obtained, and the surface is nodular. The following chart shows variation of grain size with current density at 20, 30, and 58 deg. C. and acidity of 50 g. of H_2SO_4 per liter:



A.C.S. MEETS

Oxidation of Unvulcanized Rubber—It has been shown that tackiness developed during exposure of unvulcanized rubber to light is due to oxidation and that presence of various organic materials affect to a marked extent the rate of development of tackiness. Some materials greatly increase the rate, while others inhibit it almost completely. Among the materials conspicuous in accelerating the appearance of tackiness in unvulcanized rubber were the so-called antioxidants, reported J. T. Blake and P. L. Bruce, Simplex Wire & Cable Company, Cambridge, Mass. before the semi-annual meeting of the American Chemical Society in St. Louis, April 7-11.

There was no proof that tackiness is proportional to the extent of oxidation and all results were qualitative. The authors developed an apparatus to study quantitatively this oxidation in the presence of light and at various temperatures. These quantitative experiments, in general, confirm the previously obtained results. Although the work is only of a preliminary nature, it has been found that absorption of oxygen is approximately linear with time. So-called antioxidants may accelerate oxidation under these conditions. The interval between the milling of rubber and the determination of its oxidation rate has an appreciable effect on the latter, presumably due to the formation of peroxides. The opaqueness of the sample, due to added materials, retards the rate of oxidation. Some study has been made of the relative rates of oxidation in light and in the dark, both with and without catalytic materials. Oxidations have been carried out both in air and in oxygen.

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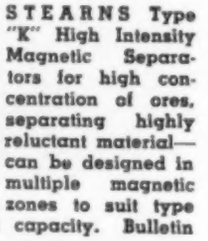

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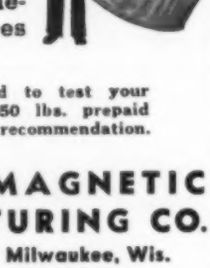

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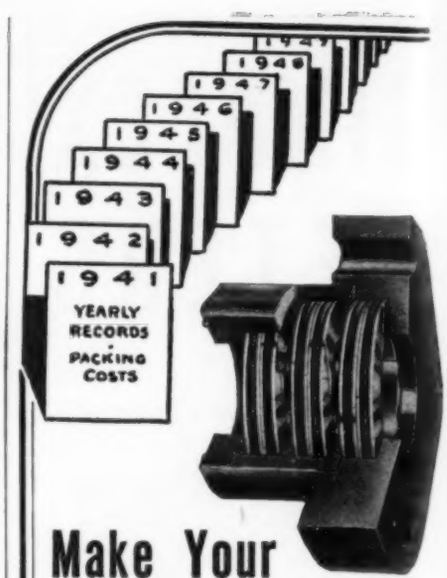
Surface Area of Carbon Blacks—Low temperature nitrogen adsorption isotherm technique, as developed by Emmett and Brunauer, presents a convenient method of determining the total surface area of very finely divided pigments, reported W. R. Smith, F. S. Thornhill, and R. I. Bray, Godfrey L. Cabot, Inc. Boston, Mass. before the American Chemical Society meeting in St. Louis. The method has been applied to a number of commercial carbon blacks. The areas obtained are in good agreement with those calculated from recent estimations of particle size. Surfaces vary from 15 sq.m. per g. for thermal decomposition blacks, to 100 sq.m. per g. for reinforcing channel blacks, and 850 sq.m. per g. for intense color blacks. While there is a general correlation of surface area and rubber reinforcement, cases have been found where blacks with nearly identical surfaces vary widely in reinforcing ability. Studies have been made of the adsorptive activity per unit area from heat of adsorption measurements. There appears to be a linear relationship between surface areas and iodine adsorption as carbon blacks of high volatile content possess a larger surface than would be anticipated from their color value or "dark field count" diameters.

Influence of Moisture Content of Carbon Black on Rubber—The effect of variation in moisture content of carbon black on properties of cured rubber such as modulus, tensile, and abrasion resistance and also on the extrusion time of an uncured rubber-black mixture was reported upon by Leonard H. Cohen and C. R. Johnson, Continental Carbon Co., New York, N. Y. before the April meeting of the American Chemical Society in St. Louis. Extrusion time at 0.2 percent moisture is more than 30 percent greater than at 4 percent moisture. This effect is larger than is to be expected on the basis of the decrease in carbon loading resulting from the increase in moisture content.

Tensile and modulus of a tread stock both tend to decrease as moisture content increases from 0.1 to 4 percent. Modulus at 400 percent elongation decreases at the rate of about 70 lb. per 1 percent increase in moisture content of carbon black. The decrease in carbon loading corresponding to 1 percent increase in moisture content of the carbon black causes a decrease in modulus of only 35 pounds. Likewise, behavior of the tensile at optimum cure vs. moisture content curve cannot be explained exclusively on the basis of variation in carbon loading. By keeping the moisture content of a standard control black constant, the reproducibility of modulus and tensile results was appreciably increased. When no particular precautions were taken to control the moisture content of the black, average deviations from the mean value of modulus at 400 percent elongation and tensile at optimum cure



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for 17 tests on identical tread stocks are 75 and 105 lb. per sq.in. respectively. Suggestions were made for equilibrating carbon black at constant humidity in order to avoid a possibly troublesome source of variation in rubber testing.

Fractionation—Simple methods for calculation of theoretical plates required for separation of two normal liquids by batch fractionation were discussed by Arthur Rose, Pennsylvania State College, before the meeting of the American Chemical Society in St. Louis. For mixtures of similar normal liquids with normal vapor liquid equilibrium relations, and in cases where the usual simplifying assumptions of distillation and negligible hold-up are justified, equations

$$n = \frac{2.85}{\log_{10}a} = R$$

and

$$n = \frac{T_B + T_A}{3(T_B - T_A)} = R$$

were suggested for estimating the equivalent number of theoretical plates *(n)* and the reflux ratio *(R)* suitable for a standard separation in which the first 40 percent distilled has an average purity of 95 mol percent. The temperatures in the above equation are °*K* and T_B is the higher temperature. The limitations of such approximation formulas were emphasized and they were compared with a correlation of more accurate Rayleigh type calculations which showed that the number of plates required may be chosen from any value within a limited range, provided the accompanying reflux is properly fixed.

Use of a third component to improve fractional distillation of liquid mixtures, such as true hydrocarbons with approximately the same boiling point, has attracted considerable interest recently, according to D. B. Keyes, University of Illinois. The basis for selection of a satisfactory third liquid and the proper design of the process for commercial operation were briefly reviewed. The relative importance of the various factors was shown, with the hope that a clearer understanding may be had of the basis of the operation and more applications can be made, especially in the petroleum industry.

Water Treatment — Recent trends and developments in coagulation and lime-soda softening of water were discussed by N. D. Doane, the Permutit Company, Charlotte, N. C., before the American Chemical Society in St. Louis. A new type of water treating equipment is represented by the Spaulding precipitator in which water being treated is first thoroughly mixed with added chemicals and previously-formed sludge, then filtered upwardly through a suspended blanket of sludge and settled in a compart-

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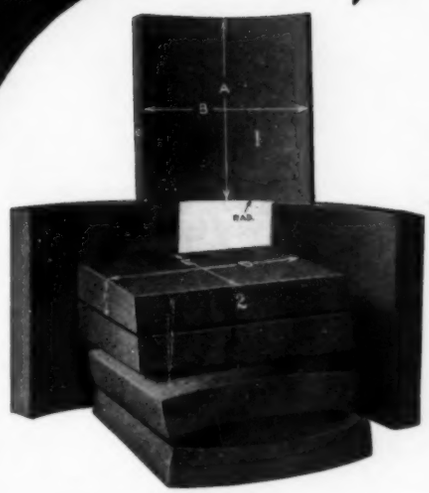

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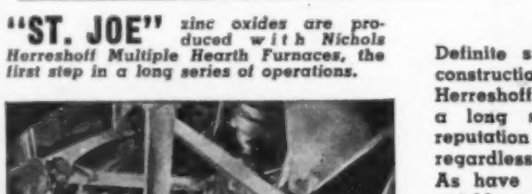

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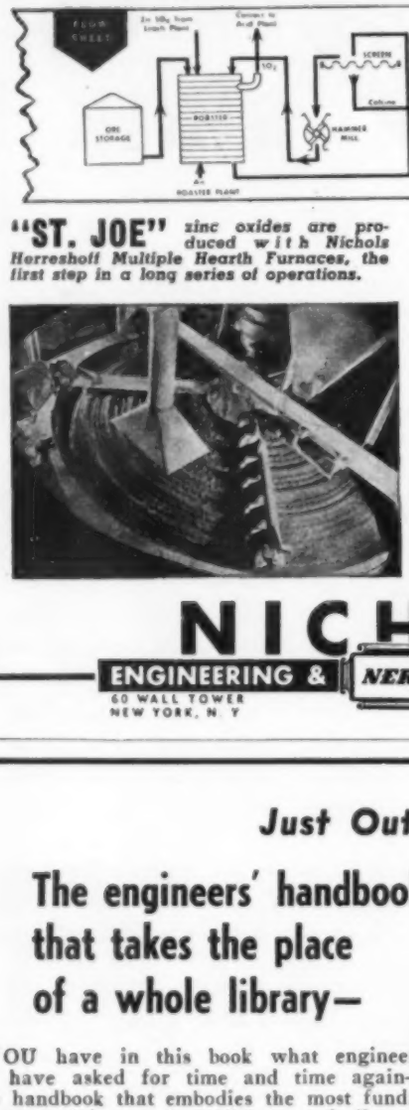

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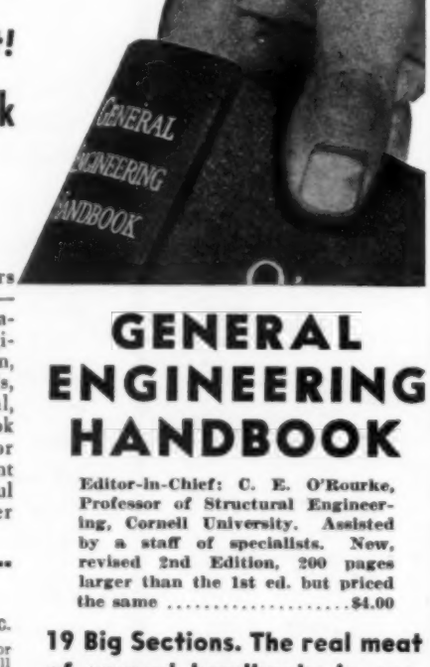

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Scale and Corrosion in Cooling Systems—Valuable and interesting conclusions have been drawn from a series of experiments with six small laboratory cooling systems, stated D. W. Haering of the D. W. Haering & Co., Research Laboratories, Chicago, before the St. Louis meeting of the American Chemical Society. Initial research proved that the small cooling systems accurately duplicated conditions found in large industrial installations and that synthetic waters may be used equally as well as natural waters for this type of research.

One study was made with a natural water in which the effect of dissolved solids concentration upon internal treatment for scale prevention was determined. Data obtained from this experiment point conclusively to the fact that controlling solids concentration is fundamental in preventing scale formation.

Scale studies were made with a synthetic water in which further investigation of solids concentration was made. Tables giving the complete analysis of raw water and tower water at the end of the experiment showed many interesting facts, including proof that sulphate and silica scales are formed in cooling systems. Relative effects of tetraphosphoglucosate and hexametaphosphate are shown clearly; the value of beta-glucoside in silica scale prevention is given further conclusive proof. Another study dealt with the effect of the chloride ion in various concentrations upon corrosion rates. Data from several corrosion and scale studies to date have been used as a basis for solving the water problems of larger systems.

Removal of Fluoride from Water—The purpose of this investigation, reported upon by R. C. Goodwin and

James Litton, Texas Technological College, Lubbock, Tex., before the April meeting of the American Chemical Society, was to determine the efficiency of a commercial pilot plant for removal of fluoride from natural waters containing approximately 5 ppm. The pilot plant was charged with 1.3 cu.ft. of "Fluorex" with a rated capacity of 358 grains of fluorine. Fifty runs were made with a rate of flow of 1.5 gal. per min. In each case the run was continued until the fluoride content reached 1 ppm. The average value of the fluoride removal was 346 grains. The average value of the fluoride content of the effluent water was 0.42 ppm.

It was shown that 1.5 gal. per min. was the optimum rate of flow for this pilot plant; 1.4 lb. of NaOH were required for each regeneration. Approximately 0.65 lb. of "Fluorex" was lost during these determinations wherein 83,700 gal. of water were passed through the pilot plant. An analysis of the regeneration and wash waters accounted for the fluorides removed.

Refractories for "Metaphos"—During the development by the Tennessee Valley Authority of a process for making calcium metaphosphate ("Metaphos"), containing about 65 percent P_2O_5 and 26 percent CaO, the selection of refractories resistant to the corrosive action of the molten product presented a major problem. As a result, it was necessary to develop a laboratory method to test different commercial refractories under conditions that would simulate the service conditions expected in a large-scale Metaphos furnace.

A description of the corrosion test method adopted and the results of tests made on 26 commercial refractories were given by Gordon R. Pole and A. W. Beinlich, Tennessee Valley Authority, Wilson Dam, Ala., before the meeting of the American Ceramic Society in Baltimore, March 30–April 5. An oil-fired, pot-type furnace, with inside diameter of 24 in. and 12 in. deep, was used. Each test consisted of suspending four 13½ x 4½ x 2½ in. standard refractory shapes from the furnace crown so as to dip into molten Metaphos to a depth of 2-3 in. The bath was maintained at 1,300 deg. C. for 66 hours. A linear flow past the brick of approximately 3-4 ft. per min. was imparted to the surface of the molten mass by the blast from oil burners. Fresh Metaphos was added at hourly intervals in order to maintain a constant bath level and to compensate for change in composition caused by solution of the test brick. The degree of corrosion was measured by determining the volume and weight changes of each refractory. The results obtained approximated those found in a large-scale plant furnace. The three most resistant refractories found by the method were zircon, high-silica vacuum-cast refractories, and dense stiff-mud brick.

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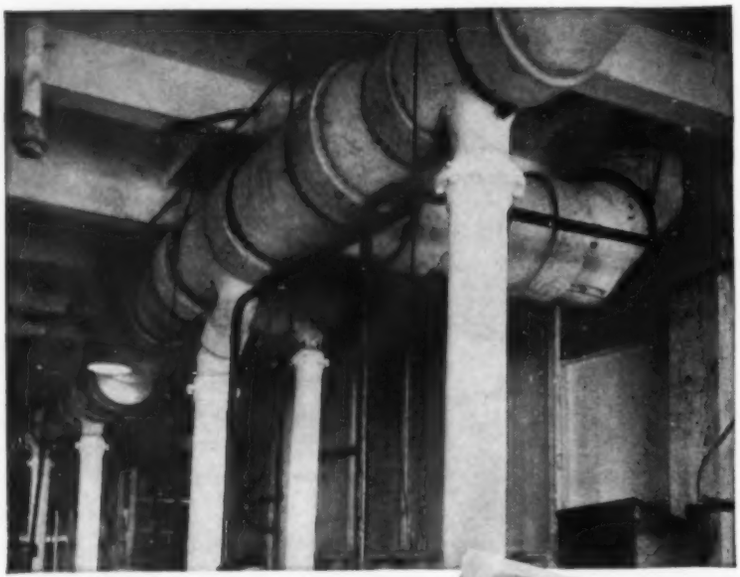

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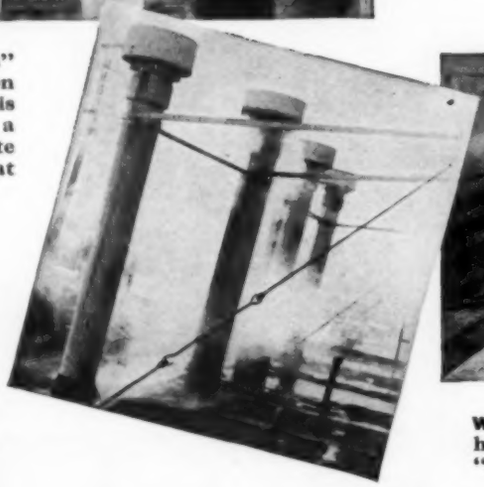
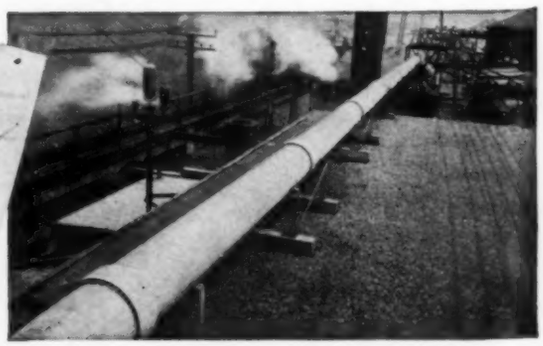


THE ASBESTOS-CEMENT composition of J-M Transite "S" Pipe makes it ideal for stacks. Besides its unusual weather-resistance, it provides low heat conductivity that keeps stack temperatures high for long distances. As a result, draft is improved and condensation minimized.



WEATHER OUTSIDE, chlorine fumes inside, have had little effect on this installation of Transite "S" Pipe in a leading industrial plant.

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ALEXANDRIAN ESSENCES

"RETORTS FROM A CHEMIST'S LABORATORY" and "ESSENCES FROM LIFE'S ALEMBIC" by *Jerome Alexander*. Published privately by the author at 50 East 41st St., New York, N. Y. 28 and 27 pages. Price $1 for set of two booklets (of which one-quarter is being turned over to the Library fund of the Chemists' Club in New York).

JEROME ALEXANDER'S persistent avocation now bears more lasting fruit than the delicate specimens he sometimes exhibits proudly in the pages of the News Edition of *I. & E. C.* Here he has brought together in two booklets more than fifty of his verses about life and about the things in it that interest him and his chemical brethren. Titles of the chemical retorts range from "The Aniline Girl," "Why Chemists Eat Pretzels," to an "Onomatopoetic Word Symphony." Among the Alexandrian Essences are in memorian tributes to Ellwood Hendrick, Julius Rosenwald, John H. Finley and to his daughter, Dorothy Alexander Livingston, who died last year. These intimate, earnest verses show true craftsmanship as well as depth of human appreciation.

TRADE-NAMES INDEX. Published by Special Libraries Association, New York, N. Y. 178 pages. Price $4 (plus postage).

NEARLY 3,500 trade names have been collected into one alphabetical list for the convenience of all who may have occasion to identify or define the numerous products known and sold under various coined names. For each of these a brief definition is given and a literature reference is usually added for further information. In general the list is concerned with materials, processes and equipment having some technical significance. In addition, a list of more than 100 sources of information on trade names is included. Registered trade marks published by the U. S. Patent Office are not included.

APPLIED HEAT TRANSMISSION. By *H. J. Stoever*. Published by McGraw-Hill Book Co., New York, N. Y. 226 pages. Price $2.50.

FREQUENTLY the preface of a technical book contains a statement to the effect that it is intended for both students and for practicing engineers. Also frequently, it is obvious to a reviewer that the book will be much more widely used as a textbook than as a reference. However, Prof. Stoever, after making a similar statement, has really written a book which justifies such a claim. The first three chapters deal with equations required for solution of conduction, radiation and convection heat exchange problems. In chapters IV and V numerous charts and tables are presented. Convection coefficients and pressure drop calculations may be made with their aid. In the last two chapters common types of heat transfer equipment and varieties of industrial insulation are described.

Twenty-eight illustrative problems, some of them requiring more than two pages for complete solution, are scattered throughout the text. The reasoning and calculations are easily followed offering designers a practical method for attacking similar problems encountered in industry.

VITAMINS POPULARIZED

WHAT ARE THE VITAMINS? By *Walter H. Eddy*. Published by Reinhold Publishing Corp., New York, N. Y. 247 pages. Price $2.50.

Reviewed by *M. I. Othmer*

"WHAT ARE VITAMINS? What do they do? Which ones do I need? How much of each do I need? Where and how can I get them?" So asks the author in his preface, and then gives "personal expression of what seems to him pertinent and reliable information —an expression resulting from his own work in the field of vitamin investigation and from his personal review of the vitamin literature"; and, further, he makes an "effort to condense it without sacrifice of accuracy."

This reviewer, who is interested only in the practical aspects of vitamins, is entirely incapable of criticizing the dozen pages (out of 250) devoted to "The Chemical Nature of the Vitamins." Most of this, with its structural formulas of large molecules, is the only pedantic touch to a careful presentation and condensation of practical, historical, and dietetic information for any intelligent layman with a lively interest in vitamins.

No sensational, highly colored, over-optimistic promises of miracles, or dogmatic ready-made conclusions prompted by wishful thinking, are here; as has been in much other material which has been released on vitamins for those interested in their use but not concerned with the deep science behind. Instead, the author picks a temperate, careful, pattern in close-packing the critically chosen conclusions of a tremendous number of workers.

After the general introductory chapters, individual chapters deal respectively with each of the vitamins known: A, B_1, Riboflavin (B_2 or G), Nicotinic Acid (P-P), B_6, other members of the B complex, C, P, D, E, and K.

A dozen fine photographs of chemists at work in the laboratories of one of the leading contributors to vitamin research and production, Merck and Co., Inc., tell the reader nothing about vitamins, although they suggest that their manufacture is a chemical laboratory business. They are decorative, however, and the general get-up of the book is excellent.

Carefully prepared bibliographies and subject and author indexes add much to the usefulness of the book. A table, "Vitamin Content of Foodstuffs" giving values per unit weight and per average serving for A, B, C, D and G for some two hundred foodstuffs rounds out the presentation in a practical manner. Thus, usable, quantitative information is given to those in food industries, diet laboratories, medical offices and hospitals, as well as to the man on the street and his wife in the kitchen.

ANODIZING

ANODIC OXIDATION OF ALUMINIUM & ITS ALLOYS. By *Dr. A. Jenny*. Translated by *Winifred Lewis*. Published by Chemical Publishing Co., Brooklyn, N. Y. 231 pages. Price $6.50.

Reviewed by *Junius D. Edwards*

LEWIS has done a service to English readers by translating Jenny's monograph on the anodic oxidation of aluminum. This is a young art and there is not much published on present commercial practices. Most of the processes in commercial use today originated in the United States and England. However, one would scarcely get this idea from reading this book, since the text is based largely on German literature and unpublished German work. Lewis has supplemented the original work by a chronological list of British patents on the anodic oxidation of aluminum. Although the text makes many references to the work of other authors, the reference to the journal in which it was published is almost invariably omitted, so that the reader wishing more details must search Chemical Abstracts and other source books to locate the original.

The first 70 pages of the book are a general review of some phases of the chemistry and physical chemistry of solutions and their behavior with metals, sometimes with particular reference to aluminum. This is followed by a discussion of the electrolytic behavior of aluminum and other "valve" metals, when used as rectifier electrodes or in electrolytic condensers.

The next 75 pages refer particularly to the anodic production of oxide coatings, such as are used today for protection and decorative purposes. A

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short section also deals with chemical surface treatment processes.

The book contains a good general description of the anodic coating processes employing sulphuric acid electrolyte, and the sealing processes using hot water, chromates, silicates, and hydrolyzable metal salts which were developed in this country and are known by the trade name, "Alumilite." These processes are also among those used in Germany under the trade name "Eloxal."

To the discriminating reader, this book will provide a useful addition to the published literature on this important subject.

METALLURGY OF DEEP DRAWING AND PRESSING. By *J. Dudley Jevons.* Published by John Wiley & Sons, New York, N. Y. 699 pages. Price $10.

Reviewed by *C. B. F. Young*

THE author has put into book form a careful, thorough, and comprehensive study of deep drawing and pressing sheets of brass, steel, aluminum, magnesium, copper, nickel, monel, nickel silver, Inconel, zinc, and stainless steel. The production and difficulties encountered in working these metals and alloys are adequately discussed and many steps are illustrated with photographs. Quite often the theoretical investigations cited are illustrated with microphotographs, graphs of physical data, and x-ray photographs.

Another interesting and valuable feature of the book deals with the equipment and materials used in producing the deep drawing and pressing of metallic sheets. Thus, one chapter each is devoted to: Presses, tools, and lubricants used in such operations.

The properties which determine the behavior of sheet stock are discussed at length. Some of the subjects covered are: Chemical composition, size of the crystals, regularity of crystal size, ductility, work hardening, hardness, directionality, reaction to annealing, surface condition and accuracy of dimension.

The author is conscious of the facts involved in the purchasing of metals and alloys on specification and has devoted a chapter each to the testing and specification of sheet metals. It is pointed out that at present the lack of knowledge of many of the properties which affect drawing and pressing handicaps adequate specification of materials for deep drawing. However, the now known important properties which affect deep drawing are discussed and suggestions for writing up such material are given. There is expressed the need for definition of terms as well as the improvements desired in metal and plant procedure.

The book has the necessary exhaustive presentation and dignity to be regarded as a treatise on this subject; and is timely in view of the importance of metal drawing and pressing in armament, ammunition, and airplane manufacture.

CURRENT LITERATURE ABSTRACTS

CONCENTRATING SULPHURIC ACID

THE ENORMOUS demand for concentrated sulphuric acid in munitions manufacture necessitated a critical study of methods and equipment used in concentrating the dilute acid. Concentration by contact with hot combustion gases is efficient for evaporating spent (denitrated) mixed acid from 68-70 percent strength to about 90-92 pereent but not for 95-97 percent acid. When evaporation by this method is carried too far the loss due to evaporation of the acid becomes excessive.

Distillation in a pot still gives high strength acid with moderate fuel consumption. The principal disadvantage is the small ratio of available heat transfer surface to the volume of acid. A new still with vertical tube banks, using wide tubes with the inner wall spirally ribbed, provides for rapid heat transfer. Each tube has its own dephlegmator and so is a complete unit. Corrosion is also a serious problem, especially along the air-liquid boundary line. To avoid breakage by thermal expansion the connection between a dephlegmator and its pot or tube must be made not too rigid.

Kessler type concentrators have been improved so that they produce 97-98 percent acid from spent mixed acid with about 13 percent fuel consumption, as against former consumption of 16 percent fuel in producing 95 percent acid.

Digest from "Concentration of Sulphuric Acid," by P. Parrish, *Industrial Chemist*, 17, 41, 1941. (Published in England.)

PRESSURE TREATMENT OF MOTOR FUEL

ACTING on the suggestion that lubricants might be obtainable by high pressure polymerization, a synthetic gasoline ("Kogasin") was subjected to high pressures (5,000 kg. per sq. cm. for one, two and four hr. and 11,700 kg. per sq. cm. for one, two and five hr.) and results were noted. The most conspicuous effect was a change from clear water-white color to a turbid dark brown. There was a small, irregular increase in refractive index. It is evident that both chemical and physical changes occur under high pressure. It is not yet proved that pressure alone is responsible; there may be other influences such as catalytic effects of the container wall.

The expected polymerization of a highly unsaturated gasoline was not achieved, but some progress was made in the technique of high pressure treatment. In particular, it is advisable to find a compression cylinder material which is thoroughly inert to the liquid fuel and strong enough for high pressure operations. Thin-walled platinum would serve the purpose but is too expensive since each compression cylinder can be used only once. Pressure can be applied without using a cylinder, but in that case the compression chamber must be of a suitable material. Metal to metal contact is feasible in pressing high viscosity oils, provided the surfaces are ground with extreme accuracy.

Digest from "Experiments on Changing the Properties of Kogasin by Compression at Pressures up to 12,000 Atmospheres," by Heinz Sustmann, *Brennstoff-Chemie*, 21, 246, 1940. (Published in Germany.)

SOFT SOLDERS WITHOUT TIN

SEARCH for tin-free solders has brought out a cadmium-lead solder (about 6 to 8 percent cadmium) with about 0.5 percent tin, or with none at all, and with small additions of zinc, copper, phosphorus or arsenic to control melting point and other properties. The new solder has been tested in small metal parts for electrical apparatus, and in large sheet metal soldering jobs. It has been used on iron, copper, brass, zinc, lead and silver. The solder melts at about 258 deg. C. Its breaking strength in numerous tests ranged from 160 to 325 kg., with the break sometimes at the soldered joint and sometimes elsewhere in the test piece. Following experimental tests the new solder has given good practical service in various operations in making electrical equipment.

Digest from "Soft Cadmium: Lead Solders," by Richard Schulze, *Metall und Erz* 37, 477, 1940. (Published in Germany.)

THERMOMETRY IN SWIFT GAS CURRENTS

FRICTIONAL heat is a hindrance to accurate thermometry in high speed gas currents. Tests were made with laminar and turbulent flow of gas lengthwise along a plate, and with gas flowing crosswise over cylinders, some of heat conducting and some of heat insulating material. The results show that crosswise flow over a cylinder is very unfavorable to accurate thermometry.

Satisfactorily accurate temperature measurements can be obtained in a high speed gas current by means of a pyrometer having an iron-Constantan thermocouple embedded in a steel ball 10 mm. in diameter and contained in a Prandtl baffle tube. A diffuser type pyrometer has also been used successfully. It has a Constantan-Manganin thermocouple in a nickeled steel tube 6 mm. in diameter (wall thickness 0.2 mm.) and a diffuser tip, with outlet orifices for escape of the flowing gas. Both these instruments have the advantage that their reading is not increased by turbulent flow of the gas.

For gases in laminar flow along a plate a right angle thermometer with a Constantan-Manganin thermocouple in a nickeled iron tube gives accurate measurements. It has the advantage

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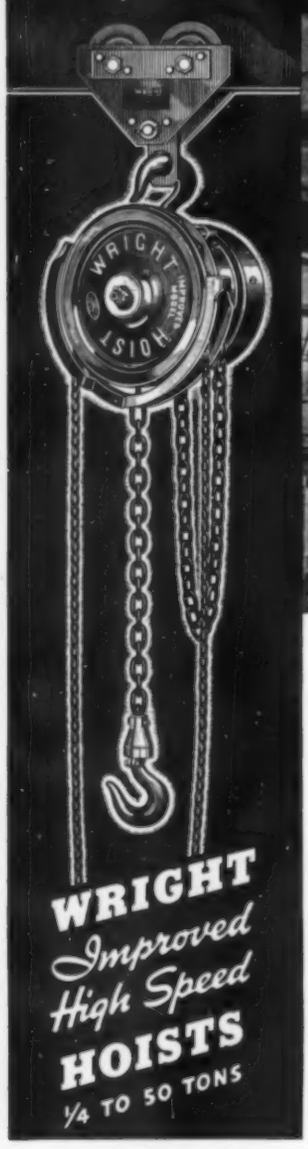

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Digest from "Thermometry in High Speed Gas Currents," by E. Eckert, *Zeitschrift des Vereines deutscher Ingenieure* 84, 813, 1940. (Published in Germany.)

GAS DISCHARGE FROM NOZZLES

FROM new tests with compressed air it has been shown that when a gas is discharged at velocities lower than the speed of sound from a narrow tube into a wide tube the pressure in the annular cross section of the wide tube is the same as the pressure at the orifice cross section. If the gas discharge takes place at supersonic velocities this rule ceases to apply and the pressure in the annular cross section of the wide tube may be less than, equal to or greater than the pressure at the orifice cross section.

Two nozzles were used in the tests. One, with approximately one-inch orifice width, permitted discharge velocities up to 90 meters per sec. The other, with orifice width approximately ½ in., permitted velocities up to that of sound (302 meters per sec.). In both cases the cross section of the wide tube was four times that of the orifice. The nozzles were made of well rounded and polished phosphor bronze. For the tests at supersonic velocities two Laval nozzles were used, permitting discharge velocities up to 560 meters per sec. The tests show that Carnot's rule for calculating power losses in the sudden discharge of liquids from narrow into wide pipes can also be applied to gases at infrasonic velocities, but not at supersonic velocities.

Digest from "Pressure in the Annular Cross Section of Suddenly Widened Tubes in High Speed Air Flow," by W. Nusselt, *Forschung* 11, 250, 1940. (Published in Germany.)

DRY STORAGE IN THE TROPICS

KEEPING stored goods dry in hot damp tropical regions is a serious problem. Food products and other organic materials are especially susceptible to spoilage but machinery, munitions, chemicals and books also suffer damage and loss. The ideal solution of the problem is air conditioning but not many storage houses in the tropics can justify the expense. Practical experience has evolved certain empirical rules, such as the plantation custom of drying tobacco in a wide roomy shed with a low straw or palm leaf roof. This type of construction offers low heat storage and small radiation capacity. Tobacco, a sensitive material, is thus protected from overheating.

The best practical solution of the dry storage problem, in units which are too small for air conditioning to be profitable, is to design the building according to the material to be stored, systematically taking advantage of all opportunities for natural heating, cooling, ventilating and drying effects in the night-and-day cycle. For the many

materials which are subject to bacterial or fungus attack ventilation is important, since the attacking organisms do not thrive in fresh circulating air. Buildings should then be arranged to take advantage of all air currents, including convection currents due to thermal changes. By such expedients much of the loss now incurred could be avoided.

Digest from "Keeping Stored Goods Dry in the Colonies," by H. Behringer, *Zeitschrift des Vereines deutscher Ingenieure* **84**, 751, 1940. (Published in Germany.)

INSULATING CONCRETE

A CONCRETE which is exceptionally strong and fireproof, with electrical resistance exceeding 1,000,000 megohms per cm. per sq. cm. is made by incorporating sand and gravel in a special asphalt emulsion. The aggregate (sand and gravel) must be chosen with extreme care since some aggregates which should give good results prove to be inferior. Grading for particle size is especially important. This special concrete has a filiform porosity because of the minute occluded channels left by the last of the water as it escapes. The texture is such that moisture is effectively prevented from penetrating into the interior. The high mechanical and electrical strength of this bituminous concrete are due in part to extreme compactness, achieved by carefully maintaining suitable conditions while the concrete is setting.

The new material has many actual and potential uses in the construction of electrical equipment. An unusual feature is that after electrical breakdown the puncture left by the arc can be repaired with scarcely any loss in electrical resistance or mechanical strength. Third rail insulators and supports for high voltage equipment are being made of the new insulating concrete and many other uses are being investigated.

Digest from "Insulating Concrete With High Electrical Resistance and Dielectric Strength," by E. Lambert, *Bulletin de la Societe Francaise des Electriciens* **10**, 257, 1940. (Published in France.)

REFRIGERATION IN RAYON MANUFACTURE

BECAUSE the manufacture of viscose silk and staple fiber involves certain low temperature operations, and because successful processing of the newly spun fiber requires a conditioned atmosphere, the viscose industry has been particularly progressive and ingenious in solving its specific refrigeration problems. Artificial cooling is applied in shredding and ripening the alkali cellulose and in making the viscose solution. This calls for a special circulating system for cooling brine, designed for thermal efficiency. In conditioning air for use in manufacturing operations it has been found that absorption refrigeration is excellently suited to the situation. For this reason some thoroughly modern absorption refrigeration plants are in

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use in viscose factories, not supplanting but supplementing compression refrigeration.

In one such plant, with a capacity of 500,000 kg.-cal. per hr. at 5 deg. F., the evaporator is heated with spent turbine steam at about 1.8 atm. pressure. Heat from the liquefaction and absorber towers is drawn off by river water the maximum initial temperature of which is about 77 deg. F. The towers are built above a concrete pit which serves as a basin for the cooling water. An unusually compact arrangement was adopted for the evaporator, liquefier, absorber and heat exchanger to permit erection in a factory where only limited ground space was available.

Digest from "Refrigeration in the Rayon and Staple Fiber Industry," by W. Niebergall, *Zeitschrift des Vereines deutscher Ingenieure* **84**, 901, 1940. (Published in Germany.)

HOW TIN CORRODES

FROM chemical analysis of the scale on ancient and modern specimens of tin, or tin alloyed with lead, it appears that the first stage in corrosion is electrochemical. Essentially the process comprises formation of hydrated stannous oxide and subsequent oxidation and dehydration to stannic oxide. But when tin is exposed to seawater or brines there is also considerable chloride corrosion which presumably forms stannous chloride first, then basic tin chlorides and finally (by hydrolysis) stannous oxide and its oxidation product, stannic oxide. Probably the hydrochloric acid liberated by hydrolysis of stannous chloride makes chloride corrosion faster than oxide corrosion. There is some evidence that a relatively stable stannous stannate (probably the pyrostannate $2Sn0.3SnO_2.2H_2O$) is formed as an intermediate corrosion product which slowly oxidizes to stannic oxide.

Digest from "Corrosion of Tin and Lead-Tin Alloys," by J. A. Smythe, *Industrial Chemist* **17**, 17, 1941. (Published in England.)

HIGH VOLTAGE INSULATION

LOSSES of electrical energy in high voltage power transmission vary greatly according to the type of discharge, the breakdown strength of the air at the time, and the nature and physical condition of the insulators. Corona discharge can be prevented by adapting wire diameter to the operating frequency and antenna height in the case of antenna wires, but allowance must be made for extremes of atmospheric conditions and an ample safety factor should be included in the calculation. Arc discharges and glow discharges in air depend largely on frequency since the breakdown strength of air is constant up to about 20,000 herz, then gradually decreases to about four-fifths of the low frequency value (reaching this minimum at about 3,000,000 herz) and finally rises to 1.6 times the low frequency value at about 100,000,000 herz.

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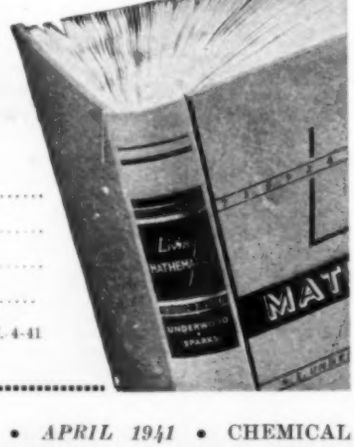

are aggravated by improper choice of insulator materials. Thus, certain plastics which have been serviceable for some insulating purposes have been used in high frequency service and are now shown by actual test to have excessively high loss factors which should have ruled them out. Insulator losses arise chiefly from one or more of four causes: 1) surface conductivity; 2) dielectric losses depending on the insulating material but often aggravated by moisture in pores; 3) surface moisture (dew, rain, ice) and dirt; 4) discharges at pores, cracks and the like. Soot deposits have relatively high conductivity and cause severe losses. All features of insulator material, surface finish and design which minimize these sources of loss aid in conserving electrical energy.

Digest from "Losses and Breakdown in High Frequency High Voltage Service," by L. Rhode and G. Wedemeyer, *Elektrotechnische Zeitschrift* **61**, 1161, 1188, 1940. (Published in Germany.)

PIEZOELECTRIC MEASUREMENTS

PIEZOELECTRIC pressure measurements have many actual and potential uses in industry as well as in laboratory investigations, because the piezoelectric response is so rapid that clearly distinguishable pressure diagrams can be obtained even for a motor operating at 3000 r.p.m. But the more sensitive the instrument is made the greater become the chances of error and much development work has been needed to make more sensitive instruments without sacrificing accuracy.

A major problem in this development has been to maintain a light, sensitive connection between pressure element and indicator while ruling out the errors which tend to accompany such a connection. Changing the shape of the quartz column to a cylindrical form was a great improvement, but it introduced certain complications of its own. It was particularly difficult to make exact allowance for atmospheric pressure. This was accomplished by providing a pressure-actuated switch which is grounded. When atmospheric pressure is adopted as the reference pressure this switch breaks the grounding connection when the measured pressure reaches that of the atmosphere. If the reference pressure is changed to three atm. the instrument will measure pressures up to that level. Thus accuracy has been greatly improved without loss of sensitivity.

Digest from "Further Development of Piezoelectric Measurement," by S. Meurer, *Forschung* **11**, 237, 1940. (Published in Germany.)

SOLUBLE DRILLING OILS FOR PLASTICS

BECAUSE casein plastics contain up to 2 percent of fat they are susceptible to damage (pore formation, stains, irregularities in texture, cracks) by fatty oils present in the plastic composition. It has been found that water-miscible oils which are used as drilling oils are particularly beneficial as

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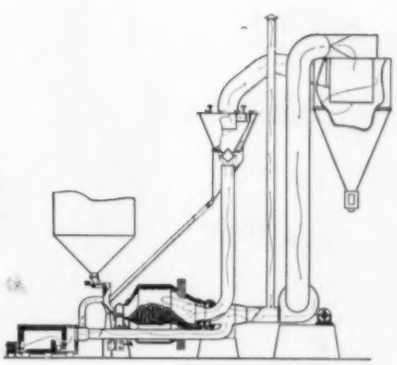

Grinds damp materials such as limestone, quartz, phosphate rock, chrome ore, coal, coke, clays, organics.

No separate dryer needed.

Only one moving part to control.

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For acid lines, use Knight-Ware pipe and fittings. The acid proof, not just resistant, quality depends upon no glaze or coating. The material itself is tough, dense and wholly inert to acid attack.

Standard and special fittings are available in bores of from 1 to 60 inches. Connections may be bell and spigot, flanged or plain.

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ingredients in casein plastics. For example, when 0.25 liter of an oil is emulsified in one to two liters of water with the aid of chlorohydrin or diethylenedioxide and added to 100 kg. of a casein composition a faultless product is obtained. The oil may be added with the dye solution in making colored plastics and many beautiful color effects are possible. Pearl luster and iridescent effects, obtained with gloss pigments, are available in great variety. Since water-miscible drilling oils are inexpensive they greatly extend the range of products obtainable from hardened casein.

Digest from "Water-Miscible Drilling Oils in Making Artificial Horn," by Werner Lück, *Kunststoffe* **30**, 235, 1941. (Published in Germany.)

CANADIAN EXPLOSIVES PLANTS

THE CHEMICAL and explosives portion of the munitions program exceeds 100 millions, and is the greatest outlay in this direction that has ever been undertaken in Canada. Construction of plants and commencement of production has, on the average, been well within the estimated schedule. Plans for 1941 provide for plant expansion at a capital cost of around 25 million. It is understood that production this year will exceed the volume expected.

The table below gives names of companies, location of plants, assistance agreements, and total commitments. The list represents only capital expenditure and is probably incomplete.

Nature of Production Under Assistant Agreements

Alberta Nitrogen Ltd.	
Calgary, Alta.	
Ammonia	$10,110,006
30 tank cars bought	207,750
Canadian Car & Foundry Co., Ltd.	
Cherrier, Que.	
Shell filling	11,390,375
Chemical Construction Corp. (Welland Chemical Co.)	
Niagara Falls, Ont.	
Ammonia, ammonium nitrate, etc.	14,535,431
Consolidated Mining & Smelting Co., Ltd.	
Trail, B. C.	
Ammonia	1,162,500
Ammonia and ammonium nitrate	7,260,830
Defence Industries, Ltd.	
Nobel, Ont.	
Cordite, T.N.T., rifle cordite	10,572,800
De Salaberry Is., Que.	
N/C cannon powder, N/C rifle powder, D.N.T., T.N.T., tetryl	18,670,973
Shawinigan Falls, Que.	
Hexachloroethane	284,375
Winnipeg, Man.	
Cordite	9,035,000
Pickering, Ont.	
St. Therese, Que.	
Ammunition filling plant	15,000,000
Beloeil, Que.	
Propellents for test purposes	75,000
Windsor, Ont.	
Carbamite	200,000
Electric Reduction Co., Ltd.	
Buckingham, Que.	
Yellow and red phosphorus	290,000
Potassium chlorate, ammonium perchlorate, potassium perchlorate, barium chlorate	131,000
General Engineering Co. (Canada) Ltd.	
Pickering, Ont.	
Filling fuses, primers, etc.	2,250,000
Nichols Chemical Co., Ltd.	
Clark Is., Que.	
Sulphuric acid	1,406,500
Shawinigan Chemicals Ltd.	
Shawinigan Falls, Que.	
Carbide	1,140,000
Monoethylaniline	237,000
Standard Chemical Co. Ltd.	
Montreal, Que.	60,000
Welland Chemical Co.	
Niagara Falls, Ont.	
Working capital	15,000

Digest from "Capital Aid to Chemical Industry," *Canadian Chemistry and Process Industries*, **25**, 115, 1941. (Published in Canada.)

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.

The Flag of the United States—Its Use in Commerce. Bureau of Foreign and Domestic Commerce, Trade Promotion Series No. 218; 10 cents.

Carbonizing Properties and Petrographic Composition of Lower Banner-Bed Coal from Keen Mountain Mine, Buchanan County, Va., and the Effect of Blending this Coal with Pittsburgh-Bed (Warden Mine) Coal, by A. C. Fieldner et al. U. S. Bureau of Mines, Technical Paper 616; 10 cents.

Single-Shot Blasting Units: Requirements fo Pemissibility, Tests Made, and Fees Charged. U. S. Bureau of Mines, Schedule 12C; 5 cents.

Form of Sulfur Occurrence in Blast-Furnace Slag, by Allan E. Martin, George Glockler, and C. E. Wood. U. S. Bureau of Mines, Report of Investigations 3552; mimeographed.

Activated Carbon from Coal Refuse for Water Purification, by S. J. Broderick and E. S. Hertzog. U. S. Bureau of Mines, Report of Investigations 3548; mimeographed.

Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma. Part 6, by H. B. Goodrich, L. E. Kennedy, and Otto Leatherock. U. S. Geological Survey, Bulletin 900-F; 50 cents.

Structural Control of Ore Deposition in the Uncompahgre District, Ouray County, Colo., with Suggestions for Prospecting, by W. S. Burbank. U. S. Geological Survey, Bulletin 906-E; 20 cents.

Developed and Potential Water Power of the World, at End of 1940. U. S. Geological Survey unnumbered mimeographed release, January 31, 1941.

Electric Power Requirements and Supply in the United States, December 1940—Class I Electric Utility Systems. Federal Power Commission, FPC P-7; 50 cents.

Technology in Our Economy, by Lewis L. Lorwin and John M. Blair. TNEC (Temporary National Economic Committee), Monograph No. 22; 35 cents.

The Basing Point Problem. TNEC Monograph No. 42; 30 cents.

Relative Efficiency of Large, Medium-Sized, and Small Business. TNEC Monograph No. 13; 50 cents.

Control of Unfair Competitive Practices Through Trade Practice Conference Procedure of the Federal Trade Commission. TNEC Monograph No. 34; 10 cents.

Control of the Petroleum Industry by Major Oil Companies, by Roy C. Cook. TNEC Monograph No. 39; 30 cents.

Development of the National Maritime Quarantine System of the United States, by Brock C. Hampton. U. S. Public Health Service, Reprint No. 2177; 10 cents.

Solar Heating of Various Surfaces, by Herman V. Cottony and Richard S. Dill. National Bureau of Standards, BMS Report 64; 10 cents.

Protection of Documents with Cellulose Acetate Sheeting, by B. W. Scribner. National Bureau of Standards, Miscellaneous Publication M168; 5 cents.

Coated Abrasive Products. National Bureau of Standards, Simplified Practice Recommendation R89-40; 5 cents.

New Fertilizer Materials, by Albert R. Merz. U. S. Department of Agriculture, Circular No. 185 (Revised); 5 cents.

The Horn Fly and Its Control, by W. G. Bruce. U. S. Department of Agriculture, Leaflet No. 205; 5 cents.

Chemicals (Industrial) Manufacturing Corporations. Federal Trade Commission, Industrial Corporation Report March 18, 1941. Available only from Federal Trade Commission, Washington, D. C.

Soldier's Handbook. War Department, Basic Field Manual. FM 21-100; 35 cents.

Laundries, Laundry Battalions, and Laundry Companies. War Department, Technical Manual TM 10-350; 10 cents.

Priority Rules. The Office of Production Management has issued, in the form of a mimeographed press release (PM 171), a revised summary of the rules under which priorities are established and administered. These regulations are important in purchasing and various procurement tasks. Available upon request to the Office of Production Management, Washington, D. C.

Urban Planning and Land Policies. Volume II of the Supplementary Report of the Urbanism Committee to the National Resources Committee. This report results from case studies of 144 communities in the United States, and deals with urban living conditions and urban land policies. National Resources Planning Board; $1.00 per copy.

Development of Resources and Stabilization of Employment in the United States. Part I—The Federal Program for National Development; 25 cents. Part III—Functional Development Policies; 15 cents. Part II—Regional Development Plans. This volume not available April 1, but to be released sometime in April.

Plant Equipment. Census Bureau figurges on new investment in plant and equipment for various industries are being published currently. These data are grouped by industries in the same way as are the figures for wage earners, wages, salaried workers, horsepower, and other data of the Census of Manufactures. Those requiring such figures on new expenditures can secure this in the preliminary form from the Bureau of Census by identification of the particular industry which is of interest. General mailings of all such data are not supplied, but a complete summary will be available in published form some months hence. All of the figures apply, of course, to the survey made last year for the industry operations in the calendar year 1939.

Raw Materials Data. Census figures on the major materials consumed by each important manufacturing industry are now being summarized and published by the Bureau of the Census. These are grouped by industries in the same manner as the rest of the Census of Manufactures. They are available on request, as indicated in the previous paragraph for equipment data.

Data on Wholesale Trade. The Bureau of the Census figures are being published currently summarizing the wholesale trade of the calendar year 1939 by industries. In most cases the industry classification is the same as that used in the Census of Manufactures. Those requiring these data should request the figures for specific industries. General mailings of all data are not provided. These data for wholesale trade relate to the merchandising after the goods are sold by the primary manufacturer. They are, therefore, quite different in scope and significance than the other figures also issued by the Census Bureau on Distribution of Manufacturers' Sales, which latter group of data are issued by the Census of Manufactures.

Directory of the Bureau of Animal Industry, Corrected to July 1, 1940. U. S. Department of Agriculture; 10 cents.

Production and Agricultural Use of Ammonium Sulfate, by C. C. Fletcher Albert R. Merz, and B. E. Brown. U. S. Department of Agriculture, Circular 578; 5 cents.

Corn in the Development of the Civilization of the Americas. U. S. Department of Agriculture, Agricultural Economics Bibliography No. 87. Available from Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C.; mimeographed.

RECENT BOOKS and PAMPHLETS

Standards on Paint, Varnish, Lacquer, and Related Products. 342 pages. Price $2. Published by the American Society for Testing Materials, Philadelphia, Pa. A compilation of 106 specifications, methods of testing and definitions. Various sections cover pigments; drying oils and thinners; shellac, varnish and var-

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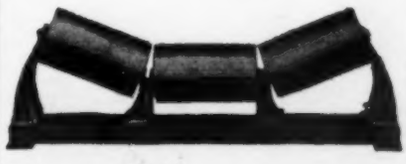
to help speed up material movement and cut handling costs. Submit your material moving problems to our engineers. Because we produce all types of material handling equipment, we can give you an impartial, intelligent recommendation. Your inquiry puts it up to us.



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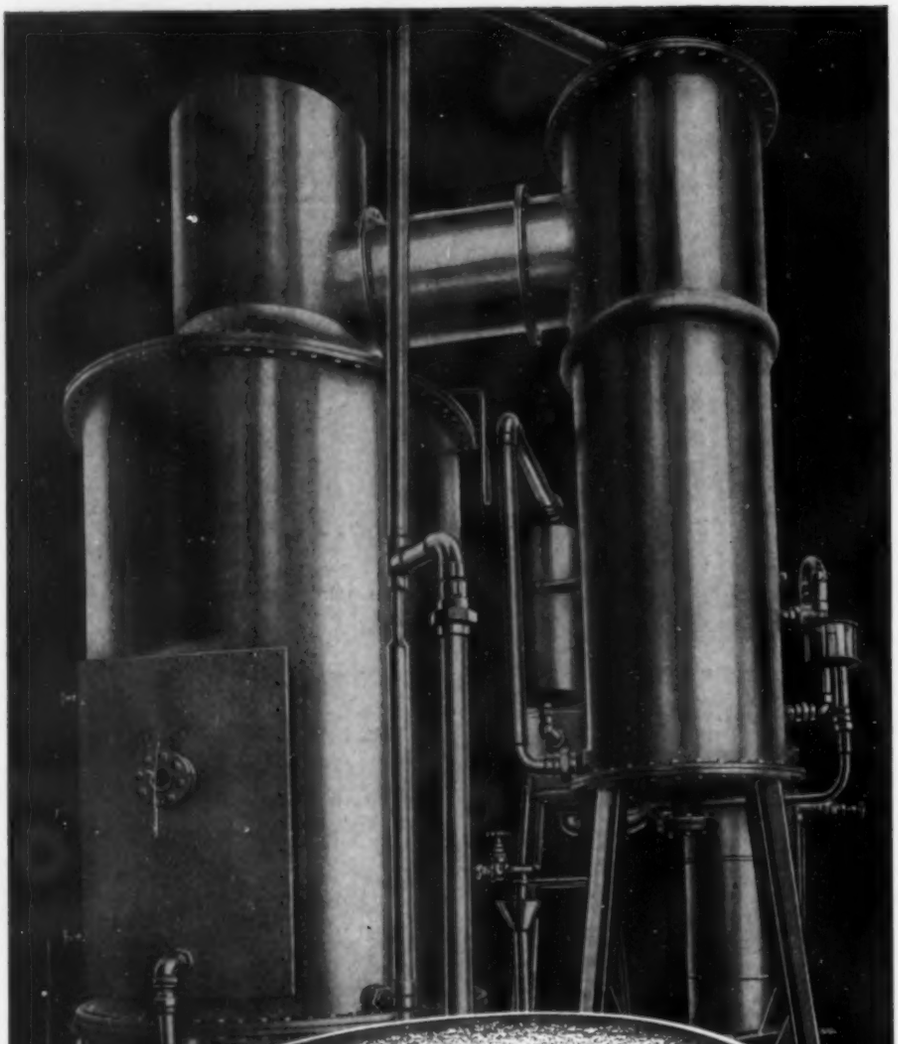

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nish materials; lacquer and lacquer materials; paint tests; putty; and miscellaneous. Since there has been no edition of the volume since 1935, this latest one is considerably amplified and revised.

Fourier Series and Boundary Value Problems. By Ruel V. Churchill. Published by McGraw-Hill Book Co., New York, N. Y. 206 pages. Price $2.50. Presents an introductory treatment of Fourier Series and their application to the solution of boundary va.ue problems in the partial differential equations of physics and engineering.

America's Factories. By M. S. Stewart. Published by Public Affairs Committee, New York, N. Y. 31 pages. Price 10 cents. Based on a long-range study of American manufacturing industries, this booklet summarizes Fabricant's book "The Output of Manufacturing Industries, 1899-1937." (See *Chem. & Met.*, Feb. 1941, p. 130.)

Airplane Metal Work, Vol. 3. By A. M. Robson. Published by D. Van Nostrand Co., New York, N. Y. 102 pages. Price $1.25. The third of this metal working series covers template making and sheet metal pattern developments. It contains the usual number of clear illustrations, as well as questions for apprentices and students, and "do's" and "don'ts" for shop workers.

List of American Standards for 1941. Published by American Standards Association, New York, N. Y. Gratis. More than 400 standards are listed, covering definitions, technical terms, specifications for metals and other materials, methods of tests for the finished products, dimensions, safety provisions for use of machinery, and methods of work. Six hundred manufacturing, government and user groups have shared in the development of these standards.

The Weekly Wholesale Price Index, 3rd Edition. By Herbert Willett. Published by the National Fertilizer Association, Washington, D. C. 42 pages. Superseding a similar report issued five years ago, this booklet describes the revisions in the construction of the widely used N.F.A. wholesale commodity price index.

Labor and National Defense. By L. G. Reynolds. Published by the Twentieth Century Fund, New York, N. Y. 130 pages. Price $1. Subtitled "A Survey of the Special Labor Problems Arising from America's Defense Activities and a Program for Action." One basic finding of the survey is that voluntary mediation, rather than legal compulsion, points the way to industrial peace under America's defense program. As a means of avoiding labor disputes leading to work-stoppages, three specific measures are recommended.

Classification, Processing and Inspection of Leather and Leather Equipment. Technical Manual GM10-226 issued by the War Department, available from the Superintendent of Documents, Washington, D. C. Price 10 cents. 41 pages. Includes, in addition to sections and classifications on processing, a section of government requirements and standards for various types of leather. The booklet also contains an extensive glossary of leather terms.

If They Could Speak. Published by Chilean Nitrate Educational Bureau, Inc., New York, N. Y. 52 pages. A series of 95 four-color illustrations of nutrient deficiency symptoms in various field plants, with descriptive identifications. Most of the Kodachromes portray magnesium, boron, and manganese deficiencies.

Handbook of Industrial Fabrics. Third edition. By G. B. Haven. Published by Wellington Sears Co., New York, N. Y. 789 pages. Price $2. Primarily concerned with cotton fibers; their use, treatment and testing. New mechanical staplers, moisture apparatus, and refined balances are described. Chapters on production, price and carry-over have been rewritten. The process industries section includes a discussion of Vinyon filter cloths.

You Might Like Chemurgy as a Career. Price 25 cents. A 15-page pamphlet prepared by the Western Personnel Service under the sponsorship of the University of California as a report of the Works Progress Administration. Gives educational and other requirements for entering the profession, defines the subject, and points out its place in the Defense Program.

MANUFACTURERS' LATEST PUBLICATIONS

Publications listed here are available from the manufacturers themselves, without cost unless a price is specifically mentioned. To limit the circulation of their literature to responsible engineers, production men and industrial executives, manufacturers usually specify that requests be made on business letterhead.

Alloy. Bethlehem Foundry & Machine Co., Bethlehem, Pa.—Bulletin BN—6 pages on this company's "Neutralloy" for stainless alloy castings, including brief discussion of development, properties, engineering characteristics, physical constants, chemical properties, etc.

Apparatus. Central Scientific Co., 1700 Irving Park Road, Chicago, Ill.—Pamphlet SMC—22 pages describing equipment for semimicro qualitative analysis; includes drawings, data on specifications and prices, and a recommended list of student apparatus in chart form.

Construction. George P. Reintjes Co., 2517-19 Jefferson St., Kansas City, Mo.—Bulletin No. 401—4-page pamphlet with brief discussion and drawings on how to stop upper side wall air infiltration on boilers and furnaces by use of drum sealing rings.

Controls. Bender Warrick Corp., Birmingham, Mich.—Catalog 241—24-page catalog describing and illustrating this company's electric liquid level controls, relay switches, magnetic contactors, and similar equipment. Included are detailed drawings, prices and specifications, as well as selection tables and application diagrams.

Conveyor. The B. F. Goodrich Co., Akron, Ohio—Catalog Section 2300—4-page pamphlet describing and illustrating by photographs the Goodrich Cord conveyor belt, its uses, construction, advantages, etc.

Corrosion. The International Nickel Co., Inc., 67 Wall St., New York.—A 35-page reprint describing in detail result of tests on the effect of sea water on various metals and alloys, with the second half devoted to a technical discussion of tests conducted on iron coupled with copper in a neutral sodium chloride solution. The booklet gives in table and graph form details of tests and results.

Chemicals. E. I. duPont de Nemours & Co., Inc., Grasselli Chemicals Dept., Wilmington, Del.—A new bulletin on sodium silicate, describing briefly its manufacture, available commercial grades, and specific uses in industry.

Chemicals. Solvay Sales Corp., 40 Rector St., New York City—Bulletin No. 1—A small folder describing briefly features and uses on this company's "Caloride" moisture-absorbing chemical for drying air or gases.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Bulletin GEA-814K—2 pages on this company's magnetic starter for induction motors, with brief description of parts and operation; Bulletin GEA-3517, 4-page pamphlet briefly describing and illustrating principles and uses of the company's speed variator; Bulletin GEA-3533, 4 pages briefly describing and illustrating this company's photo-electric relay for counting, diverting, controlling, signalling, etc.; Bulletin GEA-2981, a 2-page sheet with brief description of principal features and table of ratings and dimensions for oil-immersed magnetic switches.

Equipment. American Foundry Equipment Co., 608 S. Byrkit St., Mishawaka, Ind.—12-page booklet describing in general language this company's dust collecting equipment, with illustrations showing typical installations.

Equipment. American Locomotive Co., Alco Products Div., 30 Church St., New York, N. Y.—Bulletin No. 1025—4 pages describing briefly this company's heat exchangers, liquid to liquid for oil refinery and gasoline plant service; also Bulletin No. 1023, 4 pages on the heat exchanger, pre-fabricated piping and pressure vessel triple service offered by the company; Bulletin 2M, 4 pages on carbon steel, alloy steel and non-ferrous metal pre-fabricated piping; Bulletin No. 1024, 8 pages describing the company's feed water heaters for power plant service.

Equipment. Lee B. Mettler Co., 406 S. Main St., Los Angeles, Calif.—Bulletin F2—4-page pamphlet describing briefly this concern's automatic "entrained combustion" motorized fan gas burner assembly, featuring the new automatic safety pilot and triple controls. Included is a table giving mechanical and capacity details of the gas burners.

Equipment. Link-Belt Speeder Corp., 301 W. Pershing Road, Chicago, Ill.—Catalog No. 1885—16-page illustrated catalog on this company's shovels, draglines, and cranes, pointing out features such as construction, capacity, and handling; 7 pages are devoted to dimensions, diagrams, specifications, etc.

Equipment. Johnson Bronze Co., 300 S. Mill St., New Castle, Pa.—1941 catalog, containing 76 pages, describing in detail this company's bronze bushings, bearings, and bronze bars including extensive data in table form on engineering features and dimensions; includes a comprehensive price list on the company's bearing bronze.

Equipment. D. W. Haering & Co., Inc., 2308 S. Winchester Ave., Chicago, Ill.—8-page pamphlet describing developments in proportioning and sampling of liquids, with drawings and illustrations to show operation and construction.

Equipment. Templeton, Kenly & Co., 1020 S. Central Ave., Chicago—Bulletin 41—8 pages describing Simplex jacks for supporting and leveling tanks, including dimensions and price lists, engineering data for vertical tank supports, height required, recommended sizes, and other engineeering data.

Equipment. The B. F. Goodrich Co., Akron, Ohio—2-page reprint describing, with illustrations, in non-technical language this company's rubber-lining department and tank lining developments.

Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Leaflet F-8598—4 pages describing equipment to restore dielectric strength of insulating liquids, accompanied by photographs and blueprint diagrams illustrating important features and principles.

Filters. Dorr Co., Inc., 570 Lexington Ave., New York, N. Y.—10 pages dealing with the automatic magnetite filter designed and manufactured by Filtration Equipment Corp., including general discussion, drawing showing the principle of the filter, brief discussion of operation, fields of application, advantages, table of operating data, together with information on commercial filter installations.

Filter Scrubber. National Electric Manufacturers Co., 60 E. 42nd St., New York, N. Y.—Bulletin 740—4 pages on this company's rotary scrubber for scrubbing and acid treating filters, briefly describing advantages and operations. Also Bulletin 3000—2-page sheet on tube cleaners showing sizes of cleaners and other miscellaneous equipment.

Fire Extinguishers. Walter Kidde & Co., Bloomfield, N. J.—A wall poster describing briefly extinguishers for use on each type of fire, and necessary maintenance.

Instruments. American Instrument Co., 8010-8020 Georgia Ave., Silver Springs, Md.—Catalog XD41—184 pages describing instruments and apparatus for chemical companies, biological companies, physical, clinical, pathological, research and engineering testing laboratories, including recent addition to the company's line and data on selection.

Instruments. The Brown Instrument Co., Philadelphia, Pa.—Calendar No. G-42—Calendar for 1941, including helpful engineering information in the form

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of charts on fuel and gas analysis, steam leakage, etc., illustrated by humorous drawings.

Instruments. Manning, Maxwell & Moore, Inc., Bridgeport, Conn.—1941 edition of this company's catalog on industrial thermometers including recent additions to the company's line.

Instruments. The Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.—OB-1 edition—36-page booklet giving descriptions and drawings of hook-ups for Mercoid automatic controls with oil burner installations for steam, hot water, and warm air types of heating systems.

Instruments. Micro Switch Corp., Freeport, Ill.—36-page illustrated catalog giving complete engineering data on precision snap-action switches, including tables for dimensions, prices, operating characteristics, and illustrations of uses. Also includes information on miscellaneous types of switches and an index chart.

Instruments. W. A. Taylor & Co., Inc., 7300 York Road, Baltimore, Md.—5th edition of this company's booklet on modern pH and chlorine control, containing 79 pages of detailed information on all phases of pH and chlorine control, including various methods, theoretical discussion, chlorination, pH values, buffer systems, details of industrial applications, as well as data, illustrations, and prices of this company's slide comparators, chlorimeters, water analyzers, indicators, etc.

Instruments. Wheelco Instruments Co., 1929-33 S. Halsted St., Chicago, Ill.—Bulletin No. Z-4000—12-page condensed catalog listing principal control instruments manufactured by this company, together with brief descriptions, diagrams illustrating possible applications, models, and prices.

Mining. The Twining Laboratories, Fresno, Calif.—16-page illustrated booklet describing certain processes and operations in the mining industry, including testings, selection of treatment process, mill tests, principles of amalgamation, cyanidation, and flotation, spectrographic examination of minerals, and testing of certain petroleum products. The pamphlet includes price charges for services rendered by this company's laboratory.

Oil Burners. National Airoil Burner Co., Inc., 1284 E. Sedgley Ave., Philadelphia, Pa.—8-page bulletin on this company's burner equipment, illustrating range of application and data on specifications.

Packaging. The General Box Co., Chicago, Ill.—An illustrated booklet pointing out how to eliminate excessive shipping weight, avoid damage claims and similar information. Several pages are devoted to this company's cleated corrugated containers.

Power Generation. Bardco Mfg. & Sales Co., Dayton, Ohio—Form B530—4 pages discussing briefly the line of master generating plants manufactured by this company, including photographs to illustrate design and construction details.

Power Transmission. The American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa.—Catalog R41—12 pages on this company's reduction drives showing features and illustrating in detail typical application, with tables on engineering data on type of load, correction factors, dimensions, etc. Also Catalog W41 on this company's Wedgbelt drives with 40 pages of detailed engineering data on specifications, list prices, correction factors, selection tables, and data for calculation.

Power Transmission. Graham Transmissions, Inc., 2711 N. 13th St., Milwaukee, Wis.—Manual No. 501—A manual summarizing applications of various types of variable speed transmissions and giving data on this company's variable speed transmissions, together with illustrations and typical installations.

Power Transmission. John A. Roebling's Sons Co., Trenton, N. J.—Catalog J862—15-page illustrated booklet describing this company's metallic and non-metallic parkway cables, including in table form engineering data on stranded and solid conductors of the

company's various cables that can be applied to a variety of industrial, mining and other underground uses.

Pumps. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Leaflet B6153—4 pages on this company's engine-driven centrifugal pumps, with illustrations and brief descriptions of the various types, including a chart of overall dimensions and a complete centrifugal pump selection table.

Pumps. Denver Equipment Co., 1400 17th St., Denver, Colo.—Bulletin P8-B—8 pages on this company's adjustable-stroke diaphragm pumps, with engineering data, construction and application information.

Pumps. De Laval Steam Turbine Co., Trenton, N. J.—4-page reprint dealing with variable-speed couplings between motor and pumps and variable-speed couplings between pumps, including drawings and engineering data in the form of graphs, and discussion of methods of cutting operating costs.

Pumps. T. Shriver & Co., 810 Hamilton St., Harrison, N. J.—Bulletin No. 112—4 pages on this company's diaphragm pumps which discusses costs, tabulates types and sizes and discusses briefly installation and range of service.

Respirators. Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa.—Bulletin No. CR-7—one-page sheet illustrating this company's respirator eye-shields for dust safety and eye protection.

Safety Mats. Wm. F. Klemp Co., 6601 South Melvina Ave., Chicago, Ill.—4 pages on roll-up steel safety mats available in lengths to 25 ft. and widths to 6 ft. to insure footing in otherwise slippery locations.

Steam Generation. Combustion Engineering Co., 200 Madison Ave., New York, N. Y.—Catalog PC-6—34 pages on this company's direct-fired systems for burning pulverized coal, describing various pulverizing systems and burners, and their automatic control, as well as numerous actual installations, portrayed in drawings. Also Catalog HRT-11, 16 pages with description and engineering data on horizontal return tubular boilers.

Tanks. Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago, Ill.—19 pages with illustrations showing typical installations of this company's radial-cone bottom elevated water tanks covering a wide range of capacities.

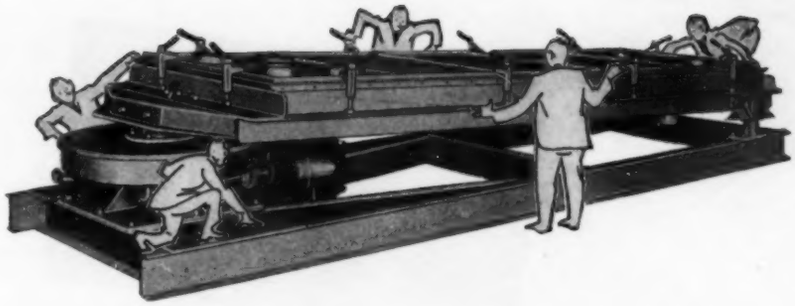
Valves. Automatic Switch Co., 41 East 11th St., New York, N. Y.—Catalog Section 3-V—8 pages with engineering data on this company's safety shut-off and manual reset valves for air, water, steam and gases. Also Catalog Section 9-V, 8 pages on four-way pilot valves operated by plain and explosion-proof solenoids, for control of double-acting hydraulic cylinders.

Valves. R. S. Products Corp., Wayne Junction, Philadelphia, Pa.—Bulletin 8B—12 pages giving advantages, models and methods of operation, construction, application, and engineering tables on this company's blast gate valves for control of air, gas, heat and liquids.

Water Treatment. American K. A. T. Corp., 122 E. 42nd St., New York—a new booklet explaining the theory of organic colloidal action and briefly discussing modern tread in water treatment.

Water Treatment. Cochrane Corp., 17th and Allegheny Ave., Philadelphia, Pa.—Publication 3000—48 pages on this company's hot process water softeners for removal of hardness, silica and other scale forming material from boiler feed and industrial process waters, discussing principles, various treating methods, equipment used, and supplementary equipment. Includes a 9-page appendix on feed-water chemistry and shows heat balances, flow diagrams and construction details.

Water Treatment. The Permutit Co., 330 W. 42nd St., New York—Bulletin 2168—A 2-page sheet describing the Permutit process for demineralizing water, with typical flow sheet using special Zeolite material in a two-step operation.



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MIXING
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Net Annual Return	$2,175

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Value, at $8 per ton	$48,000
All drying costs	29,760
Net Annual Return	$18,240
INCREASE IN NET ANNUAL RETURN,	$16,065

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CONSUMPTION OF CHEMICALS IN MARCH RETURNED TO THE RECORD LEVEL ESTABLISHED IN JANUARY

Chem & Met ECONOMICS and MARKETS

CONSUMPTION of chemicals last month was closely in line with that reported for January. Manufacturing activities were stepped up in the pulp and paper, paint and varnish, steel, textile, leather, and plastics industries but these gains were largely offset by lower output of superphosphates, refined petroleum, and rayon, the latter having been affected by the closing of one plant owing to labor troubles. The weighted index number

***Chem. & Met.'s* Weighted Index For Chemical Consumption**

	January revised	February
Fertilizers	32.03	28.70
Pulp and paper	20.30	20.25
Petroleum refining	14.45	13.21
Glass	14.40	13.57
Paint and varnish	11.23	10.94
Iron and steel	12.80	12.05
Rayon	12.40	11.63
Textiles	10.72	10.05
Coal products	9.65	8.71
Leather	4.70	4.58
Explosives	5.26	4.91
Rubber	3.69	3.51
Plastics	3.38	3.32
	155.01	145.43

for chemical consumption in March is 155 based on preliminary figures. This compares with revised numbers of 145.43 for February and 155.01 for January. In 1940 the index numbers were 144.85 for January, 129.22 for February, and 133.61 for March.

With the exception of the industries which show wide seasonal trends—of which fertilizer manufacture is typical—near-capacity operations are being maintained but the labor situation has retarded general progress and has complicated the outlook for future activities.

About the middle of last month one of the new powder plants got into operation and others are being rushed to completion so that from now on, black powder production will add materially to demand for chemicals.

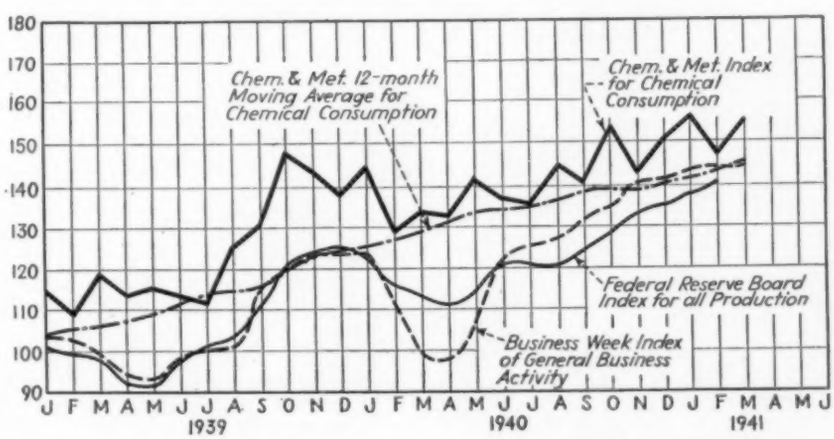
Considerable interest has been directed to the growing scarcity of certain raw materials and the establishment of priority lists. While some anxiety has been expressed regarding future supplies of some pigments and drying oils, chemical outputs, in general, are regarded as sufficient to take care of consuming requirements. It is true that some chemicals are fully sold ahead and high prices are paid for spot stocks, yet the large consuming industries are receiving regular monthly deliveries and there are few instances where any allocation of stocks may be necessary. As a matter of fact where shortages already have become apparent and the question of substitute materials has arisen, the solution generally has pointed to the use of materials which require chemicals in their manufacture.

The record output of chemicals in the first quarter of this year is readily explained by the unusually large amounts of raw materials which were required in the manufacturing industries. Preliminary figures indicate that automotive production exceeded that for the first quarter of 1929 which was the previous high. Incidentally trucks figured prominently in the present year total. Textile mills made an all-time high in consumption of fibers although the silk branch remains below normal. All divisions of the glass trade made their best showing and in some cases producers are behind with deliveries. Petroleum refining, steel, pulp, and plastics also are included in the list of record outputs.

An increase of 14.9 percent in freight car loadings is forecast for the second quarter of the year by the 13 shippers advisory boards. Increased shipments are anticipated for all the commodity groups with the exception of three—hay, fresh vegetables, and live stock. For chemicals and explosives a rise of 10.9 percent is estimated for the quarter as compared with the second quarter of last year. Percentage increases for some of the other groups are: automobiles 26.7; iron and steel 38.9; paper 7.2; salt 2.6; petroleum and products 3.1; and fertilizers 1.1.

The volume of revenue freight moved by motor trucks in February was seasonally lower with a drop of about 9 percent from the January tonnage. However, the total was 29.2 percent larger than that reported for February last year.

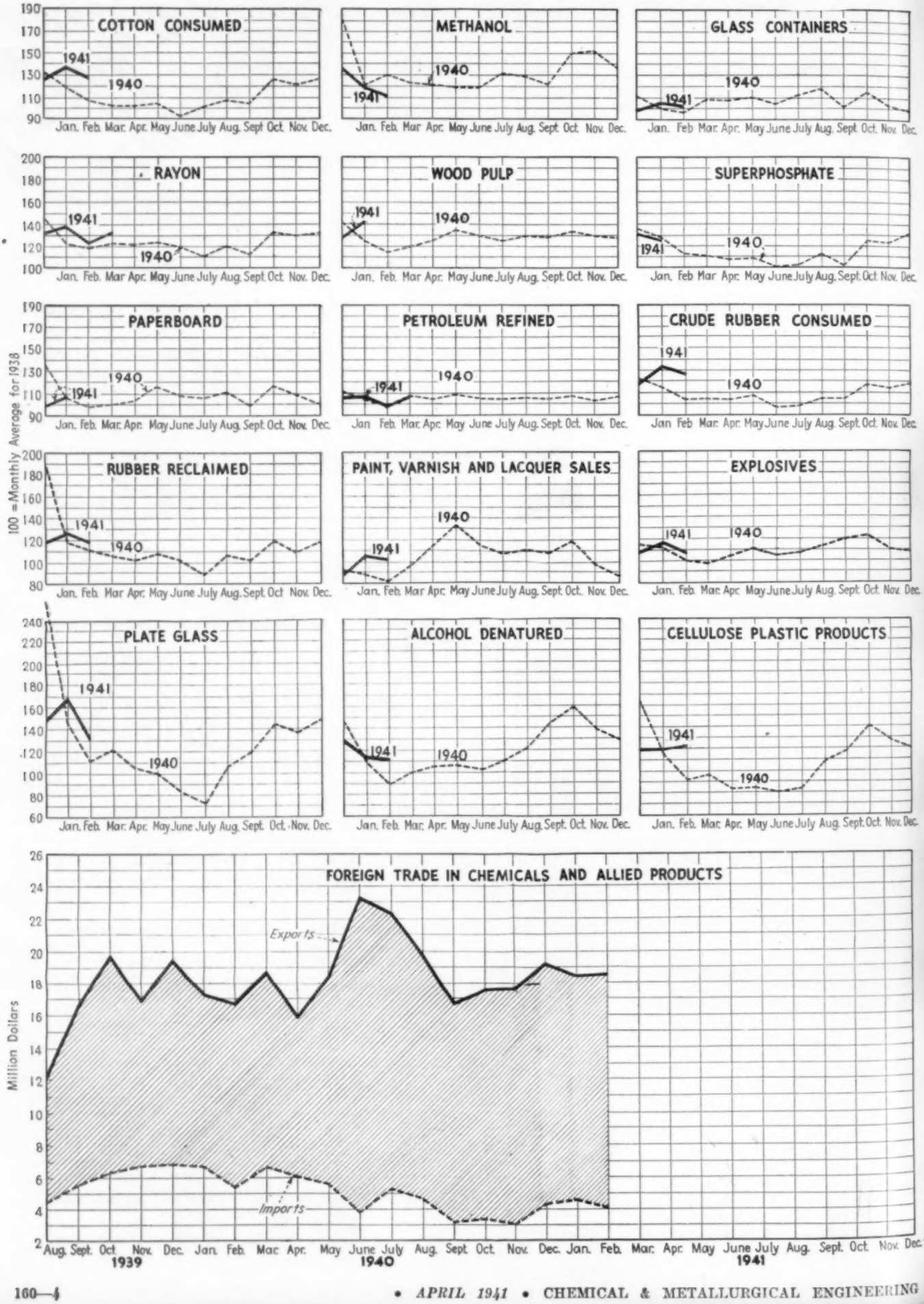
Search for substitutes and ways to conserve metals and minerals vital to the nation's armament effort is being stepped up. The special committee of the National Academy of Sciences which had reported on manganese conservation and on nickel supplies has now been asked by OPM to make thorough technical inquiry into the situation in a dozen other similar fields.


Chem. & Met. 12-month Moving Average for Chemical Consumption
Chem. & Met. Index for Chemical Consumption
Federal Reserve Board Index for all Production
Business Week Index of General Business Activity
180
170
160
150
140
130
120
110
100
90
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
1939
1940
1941

Production and Consumption Data for Chemical-Consuming Industries

	February 1941	February 1940	Jan.-Feb. 1941	Jan.-Feb. 1940	Percent of gain for 1941
Production					
Alcohol, ethyl, 1,000 pr. gal.	22,030	20,381	46,254	41,033	12.7
Alcohol denatured, 1,000 wi. gal.	10,558	8,460	21,168	18,858	12.3
Ammonia liquor, 1,000 lb.	4,682	4,534	10,009	9,341	7.1
Ammonium sulphate, tons	58,360	53,475	123,029	113,868	8.0
Benzol, 1,000 gal.	11,765	.....	24,895	.....	...
Toluol, 1,000 gal.	2,122	.....	4,503	.....	...
Naphthalene, 1,000 lb.	5,728	.....	12,464	.....	...
Automobiles, no.	485,523	404,032	986,454	836,311	18.0
Byproduct coke, 1,000 tons	4,502	4,017	9,435	8,724	8.2
Glass containers, 1,000 gr.	4,368	4,123	8,882	8,386	6.1
Plate glass, 1,000 sq. ft.	15,664	13,175	35,014	30,432	15.1
Window glass, 1,000 boxes	1,397	1,099	2,958	2,512	17.7
Rubber reclaimed, tons	19,507	17,992	39,920	37,289	7.1
Consumption					
Cotton, bales	793,626	661,771	1,636,900	1,393,564	17.5
Silk, bales	28,111	22,485	56,536	51,991	8.7
Wool, 1,000 lb.	46,944	29,960	98,024	67,852	44.4
Explosives, 1,000 lb.	33,631	31,035	69,711	65,725	6.7
Rubber, crude, tons	61,016	49,832	125,241	104,810	19.5
Rubber reclaimed, tons	17,793	15,370	36,429	31,440	15.9

Production and Consumption Trends



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BECKMAN pH EQUIPMENT

MARKETS FOR OILS AND FATS FEATURED BY STEADILY RISING PRICE TREND

INTEREST in the markets for vegetable oils and animal fats was greatly stimulated in the past month. Increased activities in the various consuming fields has broadened the trading movement for some weeks and a strong price tone was in evidence earlier in the year. This became more pronounced in later trading and almost daily price advances were recorded for the various commodities. As a result, the weighted index number for oil and fat prices has moved up sharply and is now at a higher level than for any time since early in 1937.

Various factors have contributed to this turnabout in the market. In the first place, consuming demand has been increased and buying orders were stepped up when values began to harden. The situation surrounding imported oils and oilseeds also had a bullish significance since prices at primary points were advanced and transportation problems became complicated not only because of higher ocean freights but also because of scarcity of tonnage for moving supplies. For a long time large surpluses of lard and cottonseed oil hung over the market and had a depressing effect on values. Now the statistical position has changed and a shortage of different oils is in prospect.

The situation in drying oils has not been favorable for a long time. Normal supplies of China wood oil have not been reaching this country since China became involved in hostilities and the outlook for imports in the present year are still more unfavorable. Offerings of perilla oil likewise have been curtailed and the amount of oiticica oil from Brazil has not been large enough to add much to the total supply. Some compensation has been found in the development of castor oil as a drying oil and last year the paint and varnish trade used 24,368,000 lb. of this product. Some of the finished products essential in the defence program carry government specifications which demand the use of China wood oil in their manufacture and it is probable that some change will be made in such specifications. It is also probable that priorities will be put into action in the allotment of drying oil stocks.

Prices for chemicals maintain a firm tone but very few changes were reported for deliveries for the second quarter. In this connection, it is well to note that the great bulk of present chemical production is passing to consumers against contracts. A small part of production finds its way into the resale market with speculative influences preventing any fixed price level and with sales reported at figures far in excess of those quoted for regular contract deliveries. Considerable demand has arisen for the selections which are in limited supply and the list appears to be growing so far as the number of items involved is concerned. Among the items which have commanded high prices in the spot market are bichromates, chlorates, caustic, carbonate, and permanganate of potash, tartaric, and oxalic acids, sodium sulphide, sulphate of ammonia, and phenol.

Following advances in the metal markets some of the metal salts have gone up in price and upward revisions also were reported for second quarter deliveries for carbon black, and denatured alcohol. Active call for casein has reduced the supply and values have strengthened. Quicksilver has been too high in price according to the Commissioner of Price Stabilization who cites a figure of $180 a flask as compared with the $84 per flask price which prevailed in August 1939. Producers of monoamylamine have announced revised prices for that product at 53c per lb., they also offer monobutylamine at 40c. per lb. and monoethtlamine at 35c. per lb. These quotations are for l.c.l. quantities in drums, fob works and in each case refer to 100 percent basis. A producer of isopentane, neohexane, and isooctane is offering these products in commercial quantities. Experimental lots of 50 gal. are quoted at 75c a gal. for isopentane, $1.50 a gal. for neohexane, and $1.00 a gal. for isooctane, all fob shipping point.

In connection with the scarcity of tartaric acid and cream of tartar it is worthy of note that production of crude tartar in Spain in 1940 amounted to approximately 40 percent of the average normal production, it has been estimated by the trade, since the wine crop in the previous season was below normal. Production figures for tartar materials in 1940 were: argols, 4,000 metric tons; calcium tartrate, 2,000 tons; wine lees, 5,000 tons; and tartaric acid 2,000 tons.

CHEM. & MET.

Weighted Index of

CHEMICAL PRICES

Base=100 for 1937

This month	**100.14**
Last month	99.98
April, 1940	98.65
April, 1939	97.48

Several chemicals continue to bring high prices in the resale market but very few changes were made in contract prices for second quarter delivery. Carbon black and denatured alcohol were among the selections for which higher prices became effective.

Exports during 1940 went principally to Great Britain, United States, Argentina, and Mexico. Estimated export figures for 1940 were: Argols 2,000 metric tons; wine lees, 5,000 tons; tartaric acid, 1,000 to 1,500 tons; and cream of tartar, 200 to 250 tons.

It is reported that exports of calcium tartrate at present are prohibited, since this product is needed for domestic industries.

A report to the Department of Commerce regarding the British chemical industry states that the chemical industry's activities have not, in general been curtailed to any serious extent through lack of raw materials. Before the war, a shortage of essential materials was visualized as a possibility, should hostilities occur. To forestall such an exigency, stocks of imported commodities were built up, which have proved invaluable in maintaining uninterrupted production of finished or semi-finished goods.

It is recognized as fortunate that many important raw materials required by the chemical industry are produced in the United Kingdom. An outstanding example is salt, the basis of alkali production. Another example is coal tar, the basis of production of dyestuffs, explosives, and certain fine chemicals and drugs.

A number of important materials must be imported, however, including pyrites, phosphates, carbide, potash. Inasmuch as large quantities of these materials came from continental Europe, from which supplies can no longer be obtained, alternative sources have been found in the British Dominions and in the United States.

Marked progress is also being made in the wide research now being carried out. One result of recent work has made possible the production in the United Kingdom of certain important synthetic medicinals formerly obtained from Germany. Another phase of wartime research work in the United Kingdom is that connected with air-raid precautions, which has brought forth such developments as window-glass protection by means of plastic film, and the production of luminous pigments for alleviating traffic conditions during periods of black-out.

CHEM. & MET.

Weighted Index of Prices for

OILS & FATS

Base=100 for 1937

This month	93.76
Last month	80.58
April, 1940	78.06
April, 1939	68.25

Price advances were general throughout the market for oils and fats. In some cases the advances were considerable and the weighted index number was moved up sharply. Both imported and domestic products shared in the price advances.

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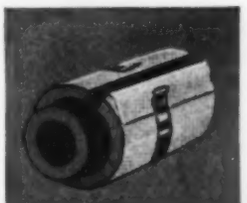

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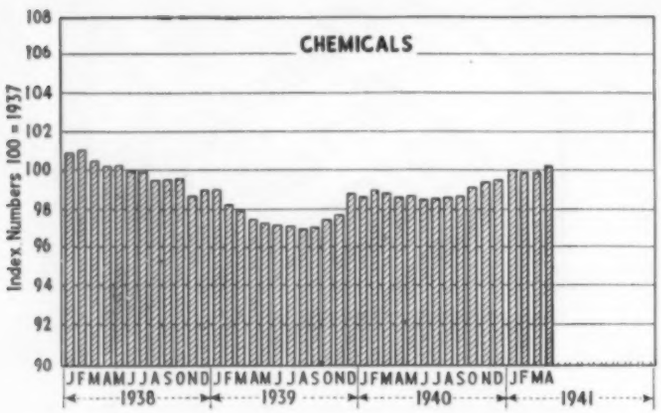
Acid, acetic, 28%, bbl., cwt	2.23 – 2.48	2.23 – 2.48	2.23 – 2.48
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. Reagent	10.25 –10.50	10.25 –10.50	10.25 –10.50
Boric, bbl., ton	106.00–111.00	106.00–111.00	106.00–111.00
Citric, kegs, lb	.20 – .23	.20 – .23	.20 – .23
Formic, cbys., lb	.10½– .11	.10½– .11	.10½– .11
Gallic, tech., bbl., lb	.90 – 1.00	.90 – 1.00	.90 – 1.00
Hydrofluoric 30% drums, lb	.08 – .08½	.08 – .08½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb	.06½– .06¾	.06½– .06¾	.06½– .06¾
Muriatic, 18°, tanks, cwt	1.05 –....	1.05 –....	1.05 –....
Nitric, 36°, carboys, lb	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –....	18.50 –20.00
Oxalic, crystals, bbl., lb	.10½– .12	.10½– .12	.10½– .12
Phosphoric, tech, c'bys., lb	.07½– .08½	.07½– .08½	.07½– .08½
Sulphuric, 60°, tanks, ton	13.00 –....	13.00 –....	13.00 –....
Sulphuric, 66°, tanks, ton	16.50 –....	16.50 –....	16.50 –....
Tannic, tech, bbl., lb	.54 – .56	.54 – .56	.54 – .56
Tartaric, powd., bbl., lb	.63 –....	.57½–....	.37¼–....
Tungstic, bbl., lb	nom....	nom....	nom....
Alcohol, amyl	–....	–....	–....
From Pentane, tanks, lb	.111–....	.111–....	.101–....
Alcohol, Butyl, tanks, lb	.09 –....	.09 –....	.09 –....
Alcohol, Ethyl, 190 p'f., bbl., gal	6.04 –....	6.04 –....	4.54 –....
Denatured, 190 proof	–....	–....	–....
No. 1 special, bbl., gal. wks.	.32 –....	.31½–....	.29½–....
Alum, ammonia, lump, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Potash, lump, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Aluminum sulphate, com. bags, cwt	1.15 – 1.40	1.15 – 1.40	1.15 – 1.40
Iron free, bg., cwt	1.60 – 1.70	1.60 – 1.70	1.60 – 1.70
Aqua ammonia, 26°, drums, lb	.02½– .03	.02½– .03	.02½– .03
tanks, lb	.02 – .02½	.02 – .02½	.02 – .02¾
Ammonia, anhydrous, cyl., lb	.16 –....	.16 –....	.16 –
tanks, lb	.04½–....	.04½–....	.04½–....
Ammonium carbonate, powd. tech., casks, lb	.09 – .12	.09 – .12	.09 – .12
Sulphate, wks., cwt	1.45 –....	1.45 –....	1.40 –....
Amylacetate tech., from pentane, tanks, lb	.10½–....	.10½–....	.10½–....
Antimony Oxide, bbl., lb	.12 –....	.12 –....	.15 –....
Arsenic, white, powd., bbl., lb	.03½– .04	.03½– .04	.03 – .03½
Red, powd., kegs, lb	nom....	.17 – .18	.15½– .16
Barium carbonate, bbl., ton	52.50 –57.50	52.50 –57.50	52.50 –57.50
Chloride, bbl., ton	79.00 –81.00	79.00 –81.00	79.00 –81.00
Nitrate, casks, lb	.08½– .10	.08½– .10	.07 – .08
Blanc fixe, dry, bbl., lb	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Borax, gran., bags, ton	43.00 –....	43.00 –....	48.00 –51.00
Bromine, cs., lb	.30 – .32	.30 – .32	.30 – .32
Calcium acetate, bags	1.90 –....	1.90 –....	1.90 –....
Arsenate, dr., lb	.06½– .06¾	.06½– .06¾	.06¾– .07
Carbide drums, lb	.04¼– .05	.04¼– .05	.04¼– .05
Chloride, fused, dr., del., ton	19.00 –24.50	19.00 –24.50	21.50 –24.50
flake, dr., del., ton	20.50 –25.00	20.50 –25.00	23.00 –25.00
Phosphate, bbl., lb	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb	.05 – .06	.05 – .06	.05 – .06
Tetrachloride drums, lb	.04½– .05½	.04½– .05½	.04½– .05½
Chlorine, liquid, tanks, wks., lb	1.75 –....	1.75 –....	1.75 –....
Cylinders	.05½– .06	.05½– .06	.05¼– .06
Cobalt oxide, cans, lb	1.84 – 1.87	1.84 – 1.87	1.84 – 1.87
Copperas, bgs., f.o.b. wks, ton	18.00 –19.00	18.00 –19.00	17.00 –18.00
Copper carbonate, bbl., lb	.10 – .16½	.10 – .16½	.10 – .16
Sulphate, bbl., cwt	4.75 – 5.00	4.75 – 5.00	4.60 – 4.85
Cream of tartar, bbl., lb	.52 –....	.47½–....	.30¼–....
Diethylene glycol, dr., lb	.22 – .23	.22 – .23	.22 – .23
Epsom salt, dom.,tech., bbl., cwt	1.80 – 2.00	1.80 – 2.00	1.80 – 2.00
Ethyl acetate, drums, lb	.07½–....	.07½–....	.06½–....
Formaldehyde, 40%, bbl., lb	.05½– .06	.05½– .06¼	.05½– .06½
Furfural, tanks, lb	.09 –....	.09 –....	.09 –....
Fusel oil, drums, lb	.16 – .17	.16 – .17	.16 – .17
Glaubers, salt, bags, cwt	.95 – 1.00	.95 – 1.00	.95 – 1.00
Glycerine, c.p., drums, extra, lb	.12½–....	.12½–....	.12½–....
Lead:			
White, basic carbonate, dry casks, lb	.07¼–....	.07½–....	.07 –....
White, basic sulphate, sck., lb	.07½–....	.07½–....	.06½–....
Red, dry, sck., lb	.0835....	.08¼–....	.07½–....
Lead acetate, white crys, bbl., lb	.11 – .12	.11 – .12	.11 – .12
Lead arsenate, powd., bag, lb	.09½– .11	.09½– .11	.08½– .11
Lime, chem., bulk, ton	8.50 –....	8.50 –....	8.50 –....
Litharge, pwd., csk., lb	.0735....	.07½–....	.06½–....
Lithophone, bags, lb	.0385 .04	.0385 .04	.036– .04
Magnesium carb., tech., bags, lb	.06¼– .06½	.06¼– .06½	.06 – .06¼
Methanol, 95%, tanks, gal	.29 –....	.29 –....	.31 –....
97%, tanks, gal	.30 –....	.30 –....	.32 –....
Synthetic, tanks, gal	.30 –....	.30 –....	.33 –....
Nickel salt, double, bbl., lb	.13½– .13½	.13½– .13½	.13 – .13¼
Orange mineral, csk., lb	.11½–....	.11½–....	.10½–....
Phosphorus, red, cases, lb	.40 – .42	.40 – .42	.40 – .42
Yellow, cases, lb	.18 – .25	.18 – .25	.18 – .25
Potassium bichromate, casks, lb	.08¼– .09	.08¼– .09	.08¼– .09
Carbonate, 80–85%, calc. csk., lb	.06½– .07	.06½– .07	.06½– .07
Chlorate, powd., lb	.10 – .12	.10 – .12	.10 – .12
Hydroxide(c'stic potash) dr., lb	.07 – .07¼	.07 – .07¼	.07 – .07¼
Muriate, 80% bags, unit	.53½–....	.53½–....	.53½–....
Nitrate, bbl., lb	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb	.19½– .20	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb	.15 – .16	.15 – .16	.15 – .16
Sal ammoniac, white, casks, lb	.0515 .06	.0515 .06	.05½– .06
Salsoda, bbl., cwt	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	17.00 –....	17.00 –....	23.00 –....
Soda ash, light, 58%, bags, contract, cwt	1.05 –....	1.05 –....	1.05 –....
Dense, bags, cwt	1.10 –....	1.10 –....	1.10 –....
Soda, caustic, 76%, solid, drums, cwt	2.30 – 3.00	2.30 – 3.00	2.30 – 3.00
Acetate, works, bbl., lb	.04 – .05	.04 – .05	.04 – .05
Bicarbonate, bbl., cwt	1.70 – 2.00	1.70 – 2.00	1.70 – 2.00
Bichromate, casks, lb	.06½– .07	.06½– .07	.06½– .07
Bisulphate, bulk, ton	16.00 –17.00	16.00 –17.00	15.00 –16.00
Bisulphite, bbl., lb	.03 – .04	.03 – .04	.03½– .04
Chlorate, kegs, lb	.06½– .06½	.06½– .06½	.06½– .06¾
Cyanide, cases, dom., lb	.14 – .15	.14 – .15	.14 – .15
Fluoride, bbl., lb	.07 – .08	.07 – .08	.07½– .08
Hyposulphite, bbl., cwt	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt	2.35 – 2.40	2.35 – 2.40	2.20 – 3.20
Nitrate, bulk, cwt	1.45 –....	1.45 –....	1.45 –....
Nitrate, casks, lb	.06½– .07	.06½– .07	.06½– .07
Phosphate, tribasic, bags, lb	2.35 –....	2.35 –....	2.25 –....
Prussiate, yel. drums, lb	.10½– .11	.10½– .11	.10½– .11
Silicate (40° dr.) wks., cwt	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr. lb	.02½– .03½	.02½– .03	.02½– .03
Sulphite, crys, bbl., lb	.02¼– .02½	.02¼– .02½	.02¼– .02¾
Sulphur, crude at mine, bulk, ton	16.00 –....	16.00 –....	16.00 –....
Chloride, dr., lb	.03 – .04	.03 – .04	.03 – .04
Dioxide, cyl., lb	.07 – .08	.07 – .08	.07 – .07½
Flour, bag, cwt	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb	.54 –....	.54 –....	.52 –....
Crystals, bbl., lb	.39 –....	.38½–....	.36½–....
Zinc, chloride, gran, bbl., lb	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb	.14 – .15	.14 – .15	.14 – .15
Cyanide, dr., lb	.33 – .35	.33 – .35	.33 – .35
Dust, bbl., lb	.09½–....	.09½–....	.07½–....
Zinc oxide, lead free, bag, lb	.06½–....	.06½–....	.06½–....
5% lead sulphate, bags, lb	.06½–....	.06½–....	.06½–....
Sulphate, bbl., cwt	3.15 – 3.25	3.15 – 3.25	2.75 – 3.00

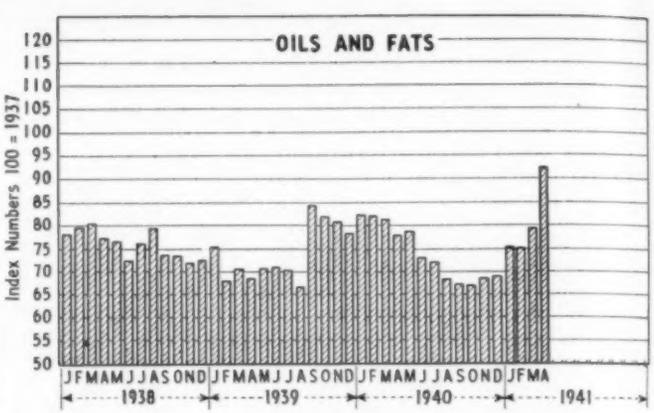
The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to April 13

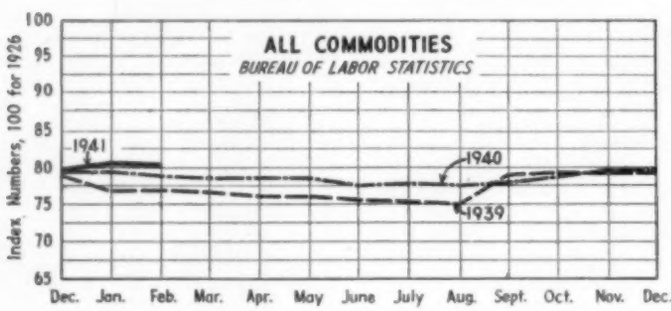
OILS AND FATS

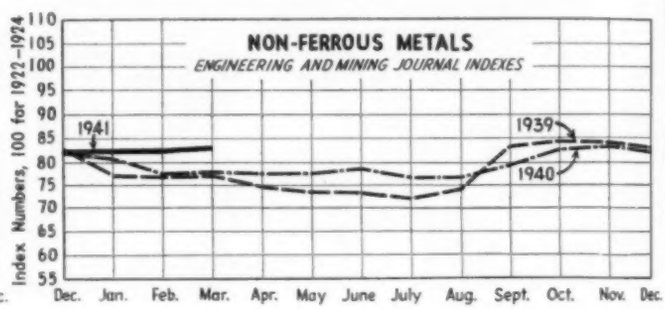
	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb	$0.10½–$0.11	$0.10½–$0.11	$0.11½–$0.12
Chinawood oil, bbl., lb	.29 –....	.28 –....	.24½–....
Coconut oil, Ceylon, tank, N. Y., lb	.05½–....	.04 –....	.03½–....
Corn oil crude, tanks (f.o.b. mill), lb	.08 –....	.06¾–....	.06¼–....
Cottonseed oil, crude (f.o.b. mill), tanks, lb	.07½–....	.06 –....	.05½–....
Linseed oil, raw car lots, bbl., lb	.105–....	.097–....	.108–....
Palm, casks, lb	.05–....	nom....	.04½–....
Peanut oil, crude, tanks (mill), lb	.08–....	.06 –....	.06½–....
Rapeseed oil, refined, bbl., gal	.95 –....	.95 –....	1.00 –....
Soya bean, tank, lb	.07½–....	.05½–....	.05½–....
Sulphur (olive foots), bbl., lb	.12½–....	.11 –....	.08½–....
Cod, Newfoundland, bbl., gal	nom....	nom....	nom....
Menhaden, light pressed, bbl., lb	.09 –....	.09 –....	.073–....
Crude, tanks (f.o.b. factory), gal	.44 –....	.37 –....	.33 –....
Grease, yellow, loose, lb	.06½–....	.04½–....	.04½–....
Oleo stearine, lb	.08 –....	.06 –....	.05½–....
Oleo oil, No. 1	.08½–....	.07½–....	.06½–....
Red oil, distilled, d.p. bbl., lb	.09 –....	.06½–....	.08 –....
Tallow extra, loose, lb	.07 –....	.05½–....	.04½–....

Chem. & Met.'s Weighted Price Indexes









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-napthol, crude bbl., lb.	$0.52 -$0.55	$0.52- $0.55	$0.52 -$0.55
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.15 - .16	.15 - .16	.15 - .16
Aniline, salts, bbl., lb	.22 - .24	.22 - .24	.22 - .24
Benzaldehyde, U.S.P., dr., lb	.85 - .95	.85 - .95	.85 - .95
Bensidine base, bbl., lb	.70 - .75	.70 - .75	.70 - .75
Benzoic acid, U.S.P., kgs., lb.	.54 - .56	.54 - .56	.54 - .56
Benzyl chloride, tech., dr., lb	.23 - .25	.23 - .25	.23 - .25
Benzol, 90%, tanks, works, gal.	.14 -.....	.14 - .14	.16 - .18
Beta-napthol, tech., drums, lb.	.23 - .24	.23 - .24	.23 - .24
Cresol, U.S.P., dr., lb	.09½- .10	.09½- .10	.09½- .10
Cresylic acid, dr., wks., gal.	.58 - .60	.58 - .60	.58 - .60
Diethylaniline, dr., lb	.40 - .45	.40 - .45	.40 - .45
Dinitrophenol, bbl., lb	.23 - .25	.23 - .25	.23 - .25
Dinitrotoluol, bbl., lb	.15½- .16	.15½- .16	.15½- .16
Dip oil, 15%, dr., gal	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, dr. fob wks., lb.	.70 -.....	.70.....	.....
H-acid, bbl., lb	.45 - .50	.45 - .55	.50 - .55
Naphthalene, flake, bbl., lb.	.07 - .07½	.07 - .07½	.06½- .07
Nitrobenzene, dr., lb	.08 - .09	.08 - .09	.08 - .09
Para-nitraniline, bbl., lb.	.47 - .49	.47 - .49	.47 - .49
Phenol, U.S.P., drums, lb.	.12 -.....	.12 -.....	.13 -.....
Picric acid, bbl., lb	.35 - .40	.35 - .40	.35 - .40
Pyridine, dr., gal	1.70 - 1.80	1.70 - 1.80	1.70 - 1.80
Resorcinol, tech., kegs, lb.	.75 - .80	.75 - .80	.75 - .80
Salicylic acid, tech., bbl., lb.	.33 - .40	.33 - .40	.33 - .40
Solvent naptha, w.w., tanks, gal.	.27 -.....	.27 -.....	.27 -.....
Tolidine, bbl., lb	.86 - .88	.86 - .88	.86 - .88
Toluol, drums, works, gal.	.30 -.....	.30 -.....	.30 -.....
Xylol, com, tanks, gal.	.26 -.....	.27 -.....	.27 -.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech, bbl., lb.	.12½- .13	.11½- .13	.09½- .13
China clay, dom., f.o.b. mine, ton.	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors			
Carbon gas, black (wks.), lb.	.03½- .30	.028- .30	.028- .30
Prussian blue, bbl., lb.	.36 - .37	.36 - .37	.36 - .37
Ultramarine blue, bbl., lb.	.11 - .26	.11 - .26	.10 - .26
Chrome green, bbl., lb.	.21½- .30	.21½- .30	.21 - .27
Carmine, red, tins, lb.	4.85 - 5.00	4.85 - 5.00	4.85 - 5.00
Para toner, lb.	.75 - .80	.75 - .80	.75 - .80
Vermilion, English, bbl., lb.	3.12 - 3.20	3.12 - 3.20	2.46 - 2.50
Chrome yellow, C.P., bbl., lb.	.14½- .15½	.14½- .15½	.14½- .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.06 - .06½	.06 - .06½	.06 - .06½
Gum copal Congo, bags, lb.	.08 - .30	.08 - .30	.06 - .30
Manila, bags, lb.	.09 - .15	.09 - .14	.09 - .14
Damar, Batavia, cases, lb.	.10 - .22	.10 - .20	.08 - .24
Kauri, cases, lb.	.18 - .60	.18 - .60	.18½- .60
Kieselguhr (f.o.b. N.Y.), ton.	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -.....	50.00 -.....	50.00 -.....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .04	.03 - .04	.03 - .04
Rosin, H., 100 lb.	2.58 -.....	2.44 -.....	.....
Turpentine, gal.	.49 -.....	.44½-.....	.34½-.....
Shellac, orange, fine, bags, lb.	.34 -.....	.27 -.....	.27 -.....
Bleached, bonedry, bags, lb.	.31½-.....	.28 -.....	.25 -.....
T. N. Bags, lb	.24 -.....	.20 -.....	.14½-.....
Soapstone (f.o.b. Vt.), bags, ton.	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N.Y.), ton.	13.75 -.....	13.75 -.....	13.75 -.....

Industrial Notes

DOWNINGTON MFG. CO., Downington, Pa., has appointed the Steel Products Sales Corp., 52 Vanderbilt Ave., as its New York representative.

RUMFORD CHEMICAL WORKS, Rumford, R. I., has completed the first part of its research laboratory. Ultimately it will house the company's research facilities and pilot plant equipment.

THE PHILADELPHIA DRYING MACHINERY CO., Philadelphia, has sold all the assets of its industrial furnace division to Stoler & Curll, Inc., of the same city.

AMPCO METAL CO., INC., Milwaukee, has named Lou R. O'Connor as its representative in Washington, Oregon, Idaho, and western Montana. He will make his headquarters in Seattle.

THERMOID CO., Trenton, N. J., announces that R. E. Spencer Geare has joined its rubber division in an engineering and sales capacity.

JOHNS-MANVILLE CORP., New York, has opened a new industrial department office at Atlanta with Thomas J. Roberts in charge.

G-M LABORATORIES, INC., Chicago, is now occupying its new modern daylight type building recently completed at 4314 North Knox Ave.

CENTRIFUGAL AND MECHANICAL INDUSTRIES, INC., St. Louis, announces that Francis E. Finch is now associated with the company.

SIMPLEX VALVE & METER CO., Philadelphia, has appointed George Goodman as exclusive in Maryland, District of Columbia, and northern Virginia. Mr. Goodman will be located at 3903 Park Heights Ave., Baltimore.

THE GROVE REGULATOR CO., San Francisco, has now moved into its new offices and plant at 1190 67th St., Oakland, Calif.

F. J. STOKES MACHINE CO., Philadelphia, has appointed F. J. Stokes, Jr., treasurer and coordinator of engineering production.

ATLAS POWDER CO., Wilmington, has acquired the business and assets of The Keratol Co. of Newark, N. J.

J. T. BAKER CHEMICAL CO., Phillipsburg, N. J., is building two new units for the production of industrial chemicals.

PETER J. SCHWEITZER, INC., Newark, N. J., has purchased the plant formerly owned by the American Salpa Corp. at Spotswood, N. J.

Ideas for your Notebook..

FROM CARBIDE AND CARBON CHEMICALS CORPORATION

New Water-Soluble "Carbowax" Compounds Provide Unique Wax Applications . . .

Have you investigated their water-soluble properties in your own applications?

THE new "Carbowax" compounds are miscible in almost all proportions with water, forming clear solutions. This unique characteristic makes them useful for all sorts of things. They can be used, for example, as lubricants that are easily removed by water without employing costly detergents or destructive alkalies. They also show great promise as plasticizers and softeners for casein, glue, gelatin, cork, and printing inks. Because of the surface-active properties of their solutions, "Carbowax" compounds minimize the settling of pigments, insure an even distribution of the particles, and in addition, act as a water-soluble binder when the film dries.

The "Carbowax" compounds are available in two forms, one resembling petrolatum and the other paraffin wax: "Carbowax" 1500 is a soft, slightly hygroscopic solid which melts at 34 to 37° C. while "Carbowax" 4000 is a hard, paraffin-like, translucent solid that melts at 50 to 55° C. and is non-hygroscopic. Further information and samples for experimental purposes are available, and will be sent without obligation on request.

For information concerning the use of "Carbowax" compounds, address:

CARBIDE AND CARBON CHEMICALS CORPORATION

Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd Street, New York, N. Y.

Metal Operations . . . "Carbowax" compounds can be used with excellent results as lubricants for wire drawing and metal extrusion operations. They also make good bonding agents for the abrasive cakes used on metal-buffing wheels. Because of their water solubility, residual pieces of the buffing compound which stick in the interstices of the metal surface are easily rinsed away with water alone.

Shoe Polishes . . . "Carbowax" compounds exert a spreading effect when aqueous, "no-rub-off" shoe polishes and cleaners are applied to shoes. They not only act as a binder when the polish dries, but also minimize settling of the pigment during storage.

Printing . . . "Carbowax" 4000 has been suggested as an overcoat on lithographed paper labels to give a glossy finish, and as an undercoat for lacquer films on paper to prevent wicking-in and retention of solvents. Its aqueous solutions can be sprayed over lithographed paper sheets to prevent sticking and offsetting between sheets, replacing the water-soluble gums now used for this purpose.

Rubber Mold Lubricant . . . A small amount of "Carbowax" 4000 in water, applied as a lubricant to molds in which rubber parts are formed, causes a perfect, quick release when the mold is opened. "Carbowax" 4000 imparts an attractive finish to the molded product and the molds require less cleaning when this releasing agent is used.

Protective Coatings . . . "Carbowax" compounds act as binders for pigments in kalsomines, water paints, and crayons. They are ingredients of lacquer and varnish removers, where they retard the evaporation of the solvent. In leather coatings, they act as plasticizers to minimize the "wicking" action of the leather.

PRODUCERS OF SYNTHETIC ORGANIC CHEMICALS

The word "Carbowax" is a registered trade-mark of Carbide and Carbon Chemicals Corporation.

Chem & Met New CONSTRUCTION

	Current Projects		Cumulative 1941	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	$65,000	$170,000	$596,000
Middle Atlantic	$7,520,000	750,000	12,760,000	14,712,000
South	1,325,000	1,890,000	10,445,000	8,995,000
Middle West	430,000	190,000	1,895,000	1,995,000
West of Mississippi	3,150,000	150,000	5,830,000	8,452,000
Far West	1,000,000	802,000	1,080,000	13,642,000
Canada	.....	.....	520,000	170,000
Total	$13,425,000	$3,847,000	$32,700,000	$48,562,000

PROPOSED WORK

Ill., Lincoln—Knox Glass Associates, Inc., 501 West Huron St., Chicago, plans to construct a factory here for the manufacture of glass food containers and bottles. Estimated cost $380,000.

Miss., Jackson—Mid-South Refining Co., H. S. Christian, Pres., Tower Bldg., Jackson, has acquired a 95 acre site adjacent to Jackson and will construct an oil refinery to manufacture gasoline, diesel oil, coal oil, motor oil and greases, to have a capacity of 6,000 bbl. per day, to be increased to 7,500 bbl. Total estimated cost of plant $1,000,000.

N. Y., Buffalo—National Aniline & Chemical Co., Inc., 1051 South Park Ave., plans to construct an addition to its plant. Estimated cost $150,000.

N. Y., Niagara Falls—Great Lakes Carbon Corp., Pine Ave., will soon award the contract for a 140x150 ft. factory. Estimated cost $70,000.

O., Cleveland—Harshaw Chemical Co., 1945 East 9th St., Cleveland, plans to construct a 1 story, 100x120 ft. process building. C. F. Dunasky, c/o Owner, engineer in charge of construction. Estimated cost $50,000.

Pa., Baldwin Township (Pittsburgh P. O.)—Hagan Corp., John M. Hopwood, Pres., Bowman Bldg., Pittsburgh, plans to construct a 2 story chemical laboratory and office building here. Press C. Fowler, Century Bldg., Pittsburgh, Archt. Estimated cost $300,000.

Pa., Point Breeze (Philadelphia P. O.)—Atlantic Refining Co., 260 South Broad St., Philadelphia, plans to construct a plant for the manufacture of aviation gasoline. Estimated cost will exceed $7,000,000.

Tenn., Memphis—Delta Refining Co., Ronnie B. Smith, Parkview Hotel, Memphis, plans to construct a skimming and vacuum plant also gasoline cracking plant, H. Taggert, Parkview Hotel, Memphis, Engr. Estimated cost $125,000 and $200,000 respectively.

Tex., Lufkin—Southland Paper Mills, Inc., E. L. Kurth, Pres., Lufkin, Tex., plans to expand existing paper mill here including installation of more grinder capacity. Estimated cost $3,000,000.

Tex., Zapata—McCullum Oil Co., Zapata and Laredo, Tex., plans to construct and equip a repressuring plant. Estimated cost $100,000.

Wash., Spokane—Henry J. Kaiser Co., Latham Sq. Bldg., Oakland, Calif., contemplates the construction of a magnesium plant at Spokane. Estimated cost will exceed $1,000,000.

Wyo., Parco—Sinclair Refining Co., 630 Fifth Ave., New York, N. Y., plans to construct an asphalt plant here. Estimated cost $50,000.

CONTRACTS AWARDED

Ala., Childersburg—War Dept., Wash., D. C., has awarded the contract for a bag loading plant here to Sullivan, Long & Hagarty, Bessemer, Ala., and Algernon Blair, First Natl. Bank Bldg., Montgomery, Ala., at $9,436,816. Plant will be operated by Brecon Loading Co., subsidiary of Coca Cola Co., Atlanta, Ga. Total estimated cost $14,394,001.

Calif., Los Angeles—Pioneer-Flintkote Co., 5500 South Alameda St., has awarded the contract for the construction of a warehouse to Myers Bros., 3407 San Fernando St., West Los Angeles. Estimated cost $100,000.

Calif., Redwood City—Pacific Portland Cement Co., 111 Sutter St., San Francisco, Calif., has awarded the contract for a gypsum lath and board plant here to W. P. Goodenough, 49 Wells Ave., Palo Alto, at $56,543, exclusive of equipment.

Calif., San Francisco—Legallett Tanning Co., 1099 Quesada Ave., has awarded the contract for the construction of a storage building to H. H. Rahlmann Co., 251 Kearny St., at $45,260.

Conn., Stratford—Raybestos Division of Raybestos-Manhattan, Inc., 75 East Main St., has awarded the contract for a 1 story, 60x360 ft. plant to O. F. Burghart, 155 Island Brook Ave., Bridgeport, at $64,800.

Ill., Antioch—Pickard, Inc., 4853 North Ravenswood Ave., Chicago, has awarded the contract for a 1 story, 50x200 ft. china factory to Andrews Construction Co., 5660 North Kedzie Ave., Chicago. Estimated cost $40,000.

Ia., Sioux City—American Lubra-Gas Corp., Sioux City, has awarded the contract for a crude oil refinery to H. S. Holtze Construction Co., 2121 East 4th St., Sioux City. Estimated cost $100,000.

Mich., Adrian—Magnesium Fabricators, Inc., Adrian, has awarded the contract for a 1 story factory to Kreighoff Co., 6661 French Rd., Detroit. Estimated cost $60,000.

Mich., Ecorse—Monsanto Chemical Co., Trenton, Mich., has awarded the contract for a 1 story, shop and storage building to Esslinger-Misch Co., 159 East Columbia St., Detroit. Estimated cost $50,000.

N. J., Harrison—National Oil Products Co., Essex St., has awarded the contract for extensive alterations and repairs to its warehouse to Mahoney-Troast Construction Co., 657 Main Ave., Passaic. Estimated cost $50,000.

N. J., Hoboken—Hinde & Dauch Paper Co., 1107 West Decatur St., Sandusky, O., has awarded the contract for an addition to its warehounse here to J. F. Mitchell, Inc., 40 Clinton St., Newark. Estimated cost $40,000.

N. J., Jersey City—Metro Glass Co., 135 West Side St., Jersey City, N. J., will build a 1 story warehouse. Work will be done by separate contracts. Estimated cost will exceed $40,000.

N. J., Newark—U. S. Industrial Chemicals, 400 Doremus Ave., has awarded the contract for a 2 story addition to its plant to Damon G. Douglas Co., 605 Broad St., Newark. Estimated cost $40,000.

N. J., Paterson—Alaska Chemical Corp., 2015 43rd St., North Bergen, N. J., has awarded the contract for general repairs and alterations to its plant to Edward Reihl Co., 85 Delaware Ave., Paterson. Estimated cost $60,000.

N. Y., Glens Falls—Imperial Paper & Color Corp., Warren St., has awarded the contract for a 60x140 ft. factory to C. E. Waggaman, 200 Glen St., Glens Falls. Estimated cost including equipment $40,000.

N. Y., Rensselaer—Bayer Co., Inc., Riverside Ave., has awarded the contract for a 3 story, 72x90 ft. factory to W. G. Sheehan Contracting Co., Inc., 28 DeWitt St., Albany. Estimated cost $50,000.

N. Y., Rensselaer—Winthrop Chemical Co., Division of Standard Products, Inc., Riverside Ave., has awarded the contract for a 60x85 ft. laboratory to Wm. G. Sheehan Construction Co., 28 DeWitt St., Albany, N. Y. Estimated cost $90,000.

N. C., Waynesville—Dayton Rubber Mfg. Co., 2342 West Riverview Ave., Dayton, O., has awarded the contract for a new factory here to Merchants Construction Co., Asheville. Estimated cost $90,000.

O., Ravenna—War Dept., Wash., D. C., has awarded additional contract for ammunition storage depot here to be operated by Atlas Powder Co., Wilmington, Del., to Hunkin-Conkey Construction Co., 1740 East 12th St., Cleveland. Estimated cost $4,039,675.

Pa., Monongahela—Ashland Oil & Refining Co., Ashland, Ky., will construct a 60,000 bbl. steel storage tank farm, connecting pipe lines, etc., along the Monongahela River. Work will be done by separate contracts. Estimated cost will exceed $50,000.

Pa., Pittsburgh—Fort Wayne Corrugated Paper Co., 2001 East Pontiac St., Fort Wayne, Ind., has awarded the contract for a 1 story, 258x320 ft. paper box factory here to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $250,000.

Pa., St. Marys—Stackpole Carbon Co., H. C., Stackpole, Pres., will construct two 1 story factory buildings with its own forces. Estimated cost $40,000.

Tenn., Chattanooga—Tennessee Products Corp., Alton Park, Chattanooga, has awarded the contract for a coke by-products plant here to Wiliputte Coke Oven Corp., subsidiary of Semet Solvay Corp., 40 Rector St., New York, N. Y. Estimated cost $1,800,000.

Tex., Dallas—Magnolia Petroleum Co., Magnolia Bldg., Dallas, has awarded the contract for the construction of a laboratory to Meers Construction Co., Great Natl. Life Bldg., Dallas. Estimated cost $50,000.

Tex., Freeport—War Dept., Wash., D. C., has awarded the contract for expansion of existing magnesium chemical plant here to Dow Chemical Co., Freeport, and Midland, Mich. Estimated cost $8,007,407.

Wash., Tacoma—St. Regis Paper Co., c/o Contractors, has awarded the contract for additions and changes in its recovery plant, installing additional digesters and auxiliary equipment, to Industrial Engineers & Contractors, 711 Middle Waterway. Estimated cost $40,000; total estimated cost including machinery $600,000.

Wis., Menasha—John Strange Paper Co., Menasha, has awarded the contract for remodeling and building addition to paper mill to Fluor Bros. Construction Co., 48 Otter St., Oshkosh.